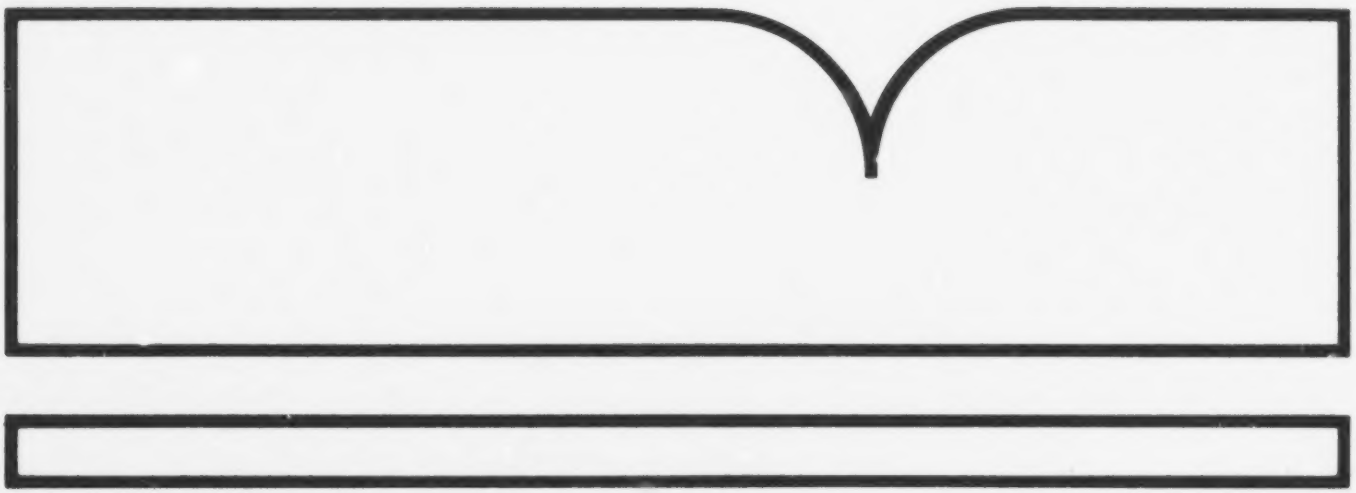
PB89-233894

Superfund Record of Decision (EPA Region 3)
Tyson's Dump, PA. First Remedial Action), March 1988

(U.S.) Environmental Protection Agency, Washington, DC

31 Mar 88



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15. Supplementary Notes

16. Abstract (Limit: 200 words)

Tyson's Dump, a 4-acre abandoned septic and chemical waste disposal site, is located in Upper Merion Township, Montgomery County, Pennsylvania. Several formerly unlined lagoons were used to store various industrial, municipal, and chemical wastes. Spills and overflows reportedly occurred during the period of operation, thus allowing for the dispersal of wastes throughout the site. Surface water runoff and seeps contributed to offsite migration of the wastes toward the Schuylkill River. The site is bordered on two sides by unnamed tributaries to the river. When the Pennsylvania Department of Environmental Resources (PADER) ordered two dumps closed in 1973, the owner of the land, General Devices Inc., removed some ponded water but did not arrange for the removal of contaminated soils. Immediate removal measures were initiated in January 1983, following an anonymous citizen complaint about conditions at the site. These measures included: construction of a leachate collection and treatment system; installation of drainage controls and a site cover; and fencing of the lagoon area. In December 1984, EPA issued an operable unit ROD for the onsite area. Remedial actions selected in the ROD include: excavation and offsite disposal of contaminated soils and sediments; and upgrading the existing air strips to treat leachate, shallow ground water, and surface run-on. EPA began the remedial design phase for this selected alternative in
(See Attached Sheet)

17. Document Analysis a. Descriptors

Record of Decision
Tyson's Dump, PA
First Remedial Action - Final
Contaminated Media: soil
Key Contaminants: VOCs (benzene, PCE, TCE)

b. Identifiers/Open-Ended Terms

c. COSATI Field/Group

18. Availability Statement	19. Security Class (This Report) None	21. No. of Pages 70
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(See ANSI-Z39.18) See Instructions on Reverse OPTIONAL FORM 272 (4-77) (Formerly NTIS-35) Department of Commerce

United States
Environmental Protection
Agency

Office of
Emergency and
Remedial Response

EPA/ROD/R03-88/045
March 1988

PB89-233894

EPA

Superfund Record of Decision:

Tyson's Dump, PA

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EPA/ROD/R03-88/045
Tyson's Dump, PA
First Remedial Action - Final

16. ABSTRACT (continued)

January 1985. In the fall of 1985, Ciba-Geigy Corporation (CGC) agreed to conduct a further investigation of the offsite area. In November 1986, CGC initiated an onsite pilot study using an innovative vacuum extraction technology process. In June and July 1987, four responsible parties, CGC, Smith-Kline Beckman, Wyeth Laboratories, and Essex Group submitted an alternative proposal to EPA for the first operable unit cleanup. This proposal incorporated the results of the vacuum extraction process for remediating lagoon soils. In September 1987, after close review of the technology, EPA decided to recommend a ROD change to include vacuum extraction. This new alternative was not available when the original Feasibility Study was conducted prior to the 1984 ROD. In addition, CGC's investigation discovered that most of the contamination from the lagoon areas had migrated into the bedrock and excavation would not remove all the contaminants from the area underlying the site. The primary contaminants of concern are VOCs. The four indicator compounds include benzene, trichloroethene, tetrachloroethene, and 1,2,3-trichloropropane.

The amended remedial action for this site includes: in-situ treatment of soils and bedrock using vacuum extraction; treatment of the vacuum-extracted water using the onsite leachate water treatment system; installation of a soil cover following treatment; and ground water monitoring. The estimated present worth cost for this remedial action is $10,200,000.

ATTENTION

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DECLARATION FOR THE REVISED RECORD OF DECISION

SITE NAME AND LOCATION

Tyson's Dump Site
Upper Merion Township
Pennsylvania

STATEMENT OF BASIS

This document is based upon the administrative record supporting the 1984 Record of Decision and information received after the administrative record was closed, which is set forth in the attached index.

DESCRIPTION OF THE SELECTED REMEDY

The Innovative Technology Remedial Action Alternative consists of the following:

- Remediation of the contaminated soils through the use of an innovative technology remedial action of vacuum extraction, down to levels determined by the Agency to be protective of human health and the environment.

DECLARATION

This decision document represents the selected remedial action for this site developed in accordance with CERCLA, as amended by SARA, and the National Contingency Plan. I have determined that the selected remedy is protective of human health and the environment, attains Federal and State requirements that are applicable or relevant and appropriate, and is cost effective. This remedy satisfies the preference for treatment that reduces toxicity, mobility, or volume as a principal element. Finally, it is determined that this remedy utilizes permanent solutions and alternative treatment (or resource recovery) technologies to the maximum extent practicable.

The Commonwealth of Pennsylvania has concurred on the selected remedy.

James M. Seif
Regional Administrator

3/31/89
Date

Tyson's Dump Site
Revised Record of Decision

Introduction

EPA and the Pennsylvania Department of Environmental Resources evaluated the innovative technology remedial action proposal made to the Agency by Ciba-Geigy Corporation, Smith-Kline Beckman, Wyeth Laboratories, and the Essex Group on June and July 1987. This Revised Record of Decision (ROD) will summarize the results of the EPA evaluation and will present a permanent remedy for the former lagoon areas.

Site Location and Description

Tyson's Site is an abandoned septic waste and chemical waste disposal site reported to have operated from 1960 to 1970 within a sandstone quarry. The site is located in Upper Merion Township, Montgomery County, Pennsylvania. Several formerly unlined lagoons were used to store various industrial, municipal, and chemical wastes. Spills and overflows reportedly occurred during the period of operation, thus allowing for the dispersal of wastes throughout the site. Surface water run-off and seeps contributed to off-site migration of the wastes toward the Schuylkill River. The approximately 4-acre plot, which constitutes a series of formerly unlined lagoons, is bordered on the east and west by unnamed tributaries to the Schuylkill River, a steep quarry high-wall to the south, and a Conrail railroad switching yard to the north (Figure 1). North of the Conrail tracks is the Schuylkill River floodplain. The area of the former lagoon lies above the 100-year floodplain.

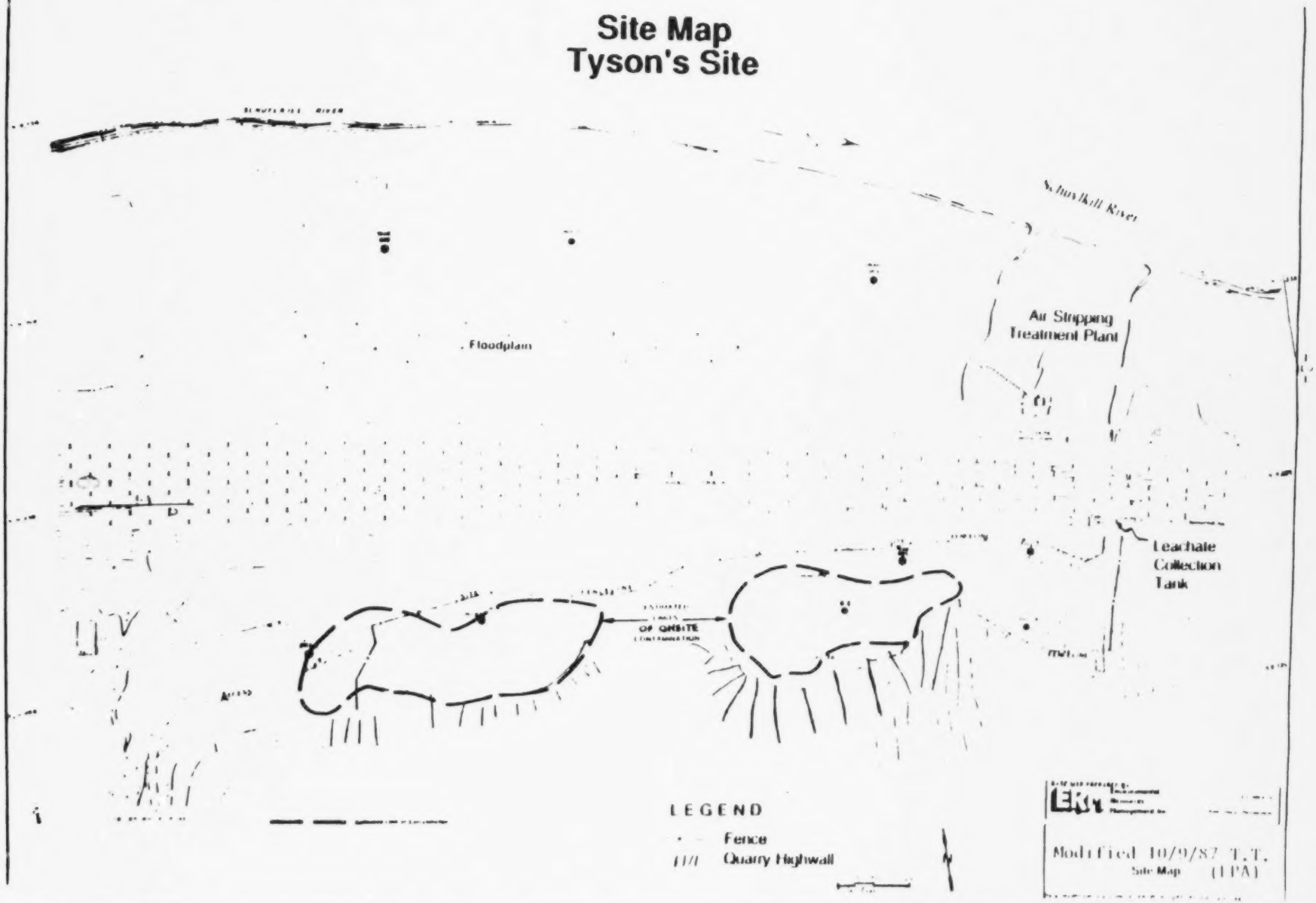
Chronological History of the Site

The Tyson's Site was owned and operated by companies owned by Franklin P. Tyson and by East Pollution Treatment, Inc. (EPTI). The stock of EPTI was owned by the current owner of the land, General Devices, Inc. (GDI) and by Franklin P. Tyson. The site was used by Tyson and EPTI for disposal of liquid septic tank waste and sludges and chemical wastes which were hauled to the site in bulk tank trucks.

The Pennsylvania Department of Environmental Resources (PADER) ordered GDI to close the facility in 1973. Although some ponded water was removed in 1973, GDI did not arrange for removal and offsite disposal of contaminated soils.

Figure 1

Site Map
Tyson's Site



In January 1983, EPA investigated an anonymous citizen complaint about conditions at Tyson's and subsequently determined that immediate removal measures were required. These measures included the construction of a leachate collection and treatment system, drainage controls and cover over the site, and the erection of a fence around the lagoon area.

Between January 1983 and August of 1984, EPA and its contractors conducted a series of investigations primarily in what is now referred to as the On-Site Area. The On-Site Area is defined here as that area south of the railroad tracks and within or immediately adjacent to the security fence erected during the emergency response measures. In December 1984, EPA issued its Record of Decision (ROD) for the On-Site Area which recommended the following remedial actions:

- Excavation and off-site disposal of contaminated soils and wastes to a permitted Resource Conservation and Recovery Act (RCRA) landfill.

- Upgrading the existing air-stripping facility to treat leachate, shallow ground water and surface run-on encountered during excavation.

- Excavation and off-site disposal of contaminated sediments within the tributary which receives effluent from the existing air stripper.

Following issuance of the ROD, EPA began remedial design for the selected alternative in January 1985. This design included additional borings throughout the lagoon area to define the volume of material to be excavated. In August 1985 through November 1985 EPA performed additional borings and magnetometer surveys throughout the lagoon area to better delineate the areas to be excavated.

In the fall of 1985, CIBA-GEIGY Corporation agreed to conduct a further investigation of the Off-Site Area, the need for which was described in the December 1984 EPA ROD. The Off-Site Area is defined here as that area outside of the security fence including the deep aquifer (bedrock aquifer). EPA subdivided the Off-Site Area into five sub-areas or "operable units." The Off-Site Operable Units included the following:

- Deep Aquifer (Operable Unit 1)
- Hillside Area (Operable Unit 2)
- Railroad Area (Operable Unit 3)
- Floodplain/Wetlands (Operable Unit 4)
- Seep Area (Operable Unit 5)

On May 27, 1986, an Administrative Consent Order (ACO) was signed between EPA and Ciba-Geigy Corporation for the Off-Site Operable Unit Remedial Investigation/Feasibility Study (RI/FS).

In November 1986 Ciba-Geigy Corporation initiated an on-site pilot study using an innovative vacuum extraction technology process. Due to zoning restrictions, the pilot study operated for only a short duration (less than 10 days). However, in May 1987, the pilot study was recommended and operated for more than three weeks.

In December 1986, Ciba-Geigy submitted a draft Off-Site Operable Unit RI Report to EPA. This report indicated that much of the site related contamination had migrated off-site into the deep aquifer toward the Schuylkill River.

On March 24, 1987, a second addendum to the offsite RI/FS work plan was submitted to EPA by Ciba-Geigy Corporation. This addendum included a detailed investigation of the Schuylkill River and the installation of wells on the north side of the river.

Current Site Status

In June and July 1987, four responsible parties, Ciba-Geigy Corporation, Smith-Kline Beckman, Wyeth Laboratories, and Essex Group submitted a proposal to EPA for clean-up of the on-site lagoon areas, upgrading of the leachate collection system and clean-up of the tributary sediments. Additionally, the parties proposed to initiate ground water remediation measures since the information contained in the draft Off-Site Operable Units RI report indicated that much of the contamination formerly in the lagoon areas was now in the aquifer system, down gradient of the site, and was discharging to the Schuylkill River.

The parties' proposal was based on a Comprehensive Feasibility Study (CFS) submitted to the Agency on June 15, 1987. The CFS was developed independently by Ciba-Geigy Corporation and was not formally commented on by EPA. The CFS incorporated the results of the innovative vacuum extraction process for clean-up of the lagoon soils, preliminary results of the Off-Site RI and additional studies for the installation

of ground water recovery wells. Some of the results of the CFS indicated that the contaminants in the bedrock underlying the lagoons would be a source of continuing contamination of the backfilled soil. The study raised the possibility that the remedy selected in the ROD would be of limited effectiveness without the installation of a barrier, which would limit upward movement of contamination from the underlying bedrock.

On July 29, 1987 Ciba-Geigy Corporation submitted the final draft Operable Units RI report to EPA. This report concluded that much of the site contamination, specifically the dense non-aqueous phase liquids (DNAPLS), were in the underlying bedrock and aquifer. The report also found that a dissolved portion of the DNAPLs was discharging into the Schuylkill River.

Comparative Evaluation of the EPA Record of Decision Remedial Action Alternatives and the Innovative Technology Remedial Action Alternative

Consistent with Section 121 (Cleanup Standards) of the Superfund Amendments and Reauthorization Act of 1986 (SARA) every remedy selected by EPA as the preferred remedy must fulfill the following requirements:

1. The remedy is protective of human health and the environment.

   - the remedy meets or exceeds contaminant specific applicable or relevant and appropriate requirements (ARARs) or other health or risk based levels, and presents no unacceptable exposure to hazardous substances.

2. The remedy attains Federal and State ARARs unless a waiver is appropriate.

3. The preferred remedy utilizes treatment and permanent solutions to the maximum extent practicable.

4. The remedy is cost-effective.

The discussion as follows focuses on these requirements as criteria for which the remedial action alternatives in the 1984 EPA Record of Decision were compared with the innovative technology remedial action alternative proposed by the responsible parties. Because the selection of treatment technologies for ground water will depend upon the final results of the

Off-Site Operable Units Remedial Investigation/ Feasibility Studies and a subsequent Record of Decision, specific action and cleanup levels for ground water remediation was not the subject of this evaluation.

Range of Alternatives

The evaluation of alternatives was based primarily on their effectiveness and implementability, as specified by the National Contingency Plan (NCP).

A. Effectiveness

An Effectiveness criterion is a measure of how well remedial alternatives or components of remedial alternatives satisfy response objectives. Factors within this criterion include:

1. Protectiveness (Long term and short term)

2. Compliance with ARARs

   •Chemical specific
   •Action specific
   •Location specific

3. Reduction in Mobility, Toxicity, or Volume (MTV)

   •Permanent and significant
   •Use permanent solutions and alternative treatment or resource recovery technologies
   •Irreversibility of treatment

4. Reliability

   •Potential need for replacement
   •Resulting risk to workers and community during operation
   •Operations and maintenance (O & M) requirements
   •Demonstrated performance or potential performance versus little or no field experience with similar sites or wastes.

B. Implementability

Implementability measures how easily remedial alternatives or components can be affected at a site. Factors include:

1. Technical Feasibility

   •Short Term
   •Long Term

The following is a summary of the remedial action alternatives identified in the 1984 Record of Decision, and of the innovative technology remedial action alternative.

1984 ROD Alternatives

1. No Action

2. Site Capping and Ground Water Diversion

3. Ground Water/Leachate Collection and Treatment; Surface Sealing of Contaminated Areas

4. Construction of an On-Site, Secure Landfill.

5. Excavation/Off-Site Removal

New Innovative Technology Alternative

6. Vacuum Extraction

ALTERNATIVES

Alternative 1 - No Action Alternative

In the No Action Alternative, no further remedial action would be taken for the contaminated soils in the former lagoon area. Under the No Action Alternative, no site erosion control or construction of run-off control structures would occur. The site would remain as it currently exists, however, the current leachate collection system would continue to operate.

A. Effectiveness

1. Protectiveness

In the short term, the No Action Alternative would allow the contaminated soils to remain essentially undisturbed. The soils which contain volatile organic compounds would still be present in the upper soils, posing potential short-term risks from dermal contact with and ingestion of contaminated soils. In the long-term, the No Action Alternative is not protective of human health and the environment.

2. Compliance with ARARs

The No Action Alternative would not meet the possible, action-specific ARARs (RCRA Interim Status Facilities Standards) for closure of waste disposal sites, such as the elimination of potential free liquids from the disposal area, control of leachate production and leachate collection.

3. Reduction in Mobility, Toxicity, and Volume

From the observations above, it follows that the No Action Alternative would not reduce the mobility, toxicity, or volume of the contaminants, and would not significantly reduce the migration of contaminants from the site.

4. Reliability

The No Action Alternative would fail to protect human health and the environment in both the short-term and long-term.

B. Implementability

The No Action Alternative would represent the current conditions on-site.

Alternative 2 - Site Capping and Ground Water Diversion

This alternative involves sealing the areas overlying the former lagoons with an impervious material and controlling the movement of the ground water through these areas with grout curtains. In this alternative, the contaminated area may be capped with a grass cover, two feet of cover soil, one foot of drainage sand or equivalent, and a membrane liner supported by a clay or soil-bentonite secondary liner (40 CFR Part 264). A minimum of 20-mil thickness membrane liner is required for RCRA caps. For maximum protection and long-term reliability, a 50-mil HDPE liner would be recommended.

A. Effectiveness

1. Protectiveness

During construction of the site cap there would be some disturbance of contaminated soils and, therefore, additional risk to the community, the environment, or site workers. The migration of contaminated soil or run-off water could be controlled by diversion ditches, sediment basins, silt fences, and dikes. Difficulties are expected in anchoring ('keying') the surface cap into the quarry highwall because of the highly fractured/jointed bedrock and because of the potential for slope movement.

This alternative will not prevent any hazardous contaminants from migrating into the ground water and surface waters. There is also no means of estimating the quantities of hazardous contaminants entering into these waters from the site.

2. Compliance with ARARs

The possible ARARs would include the performance standards for RCRA landfill closure, as established in 40 CFR Part 264. These standards include the following:

- Long-term minimization of migration of liquids through the closed landfill.
- Function with minimum maintenance.
- Drainage and minimum erosion or abrasion of the cover.
- Settling and subsidence accommodation so that cap's integrity was maintained.
- Permeability less than or equal to the permeability of any bottom liner system or natural subsoils present.

As outlined in the EPA 1984 ROD, utilizing both a synthetic and a clay cap is highly effective in preventing 1) surface water infiltration, 2) volatile organic air emissions, and 3) direct contact exposure with contaminated soils.

In evaluating this alternative with reference to site characteristics, several disadvantages were identified which may not satisfy the RCRA ARARs. These disadvantages included difficulties expected in anchoring the surface cap into the quarry highwall and complications involved in installing a grout curtain in fractured bedrock.

3. Reduction in Mobility, Toxicity or Volume

The cap alternative would reduce soil contaminant migration to a minimum by preventing its contact with infiltration. Reduction in this migration potential would be significant and essentially permanent for the life of the cap. This alternative would not reduce contaminant migration resulting from water table contact with contaminated soils; this situation could be controlled with horizontal drains if required. This alternative would not control contaminant migration from the soil into the bedrock or ground water.

This alternative would not decrease contaminant toxicity or volume. However, direct contact and inhalation threats would be reduced by the presence of a cap. After the useful life of the system, the cap could be replaced to renew the "permanence" of this containment alternative.

4. Reliability

The site cap would have a limited useful life and would eventually require replacement. However, the useful life could be extended by upgraded design and maintenance of the cap as needed.

For operation and maintenance of the cap system, water samples from monitoring wells could be analyzed to detect any increase in ground water contaminant levels. However, since the ground water is already contaminated, it would be difficult to verify system performance. If a significant increase in contamination occurred, the cap system would have to be inspected for structural failure so that appropriate repairs could be made. If signs of failure were detected after a long period of service, remedies might include mending of liner tears, recompaction of underlying soil/clay layers, or reinstallation of the entire cap.

B. Implementability

1. Technical Feasibility

This alternative has been demonstrated to be technically feasible at other sites. However, due to the nature of the fractured bedrock and the existence of the quarry highwall, it was evaluated that the integrity of any "key" or "tie-in" between the cap and quarry wall may be disrupted by long-term block or slab movement and/or seepage pressures against the quarry face.

For the long-term, this alternative may not be technically feasible. Although monitoring wells could be installed to monitor the ground water, verification of performance of the remedial action would be difficult because of the presence of pre-existing contamination in the ground water.

Alternative 3 - Ground Water/Leachate (Seep/Spring) Collection and Treatment; Surface Sealing of Contaminated Areas

This alternative is in part the same as Alternative 2 and involves sealing the areas overlying the former lagoons with an impervious material to eliminate infiltration of precipitation. A deeper and longer interceptor trench similar to the existing interceptor trench would be installed to intercept and collect any contaminated ground water leachate originating from the site.

The interceptor system would also collect water from the seeps and springs emanating from the site area. Therefore, the leachate collection system can also be termed the seep/spring collection.

A. Effectiveness

1. Protectiveness

The sealing of the lagoons would provide the same protectiveness as outlined in Alternative 2. The Leachate (Seep/Spring) Collection and Treatment system could be effective in reducing further off-site migration of contaminants into the ground water.

2. Compliance with ARARs

The possible ARARs for site capping would include those standards as outlined in Alternate 2. Specific ARARs of treatment standards would have to be attained for treatment of leachate.

3. Reduction in Mobility, Toxicity or Volume

For installation of the cap this Alternative would be the same as Alternative 2. For installation of a collection system this alternative will not ensure that hazardous substances will not migrate into the ground water; moreover, there is no means of estimating the quantities of hazardous contaminants entering into the ground water from the Site. Even if the interceptor trench were installed 5 to 10 feet deeper into the bedrock, leachate which moves through the base of the unlined lagoons into the fractured bedrock would very likely not be intercepted.

4. Reliability

The reliability of the cap is the same as Alternative 2. The reliability of a larger and deeper interceptor system would not ensure effective collection of contaminants to the ground water.

B. Implementability

1. Technical Feasibility

The technical feasibility for installation and maintenance of the cap would be the same as Alternative 2. For installation and extension of the interceptor trench, excavation would be required into the bedrock which could cause additional fracturing of the bedrock.

Alternative 4 - Construction of an On-Site, Secure Landfill

This alternative involves the placement of wastes and contaminated soils in a properly designed and constructed on-site landfill to reduce off-site migration of hazardous constituents through ground water or air, and to prevent direct contact threats.

A. Effectiveness

1. Protectiveness

A RCRA landfill, adequately designed and constructed, should be able to contain the waste for a typical design life of 30 years. Surface water infiltration would be prevented by the cap and leachate generation would be minimal. Leachate generated within the landfill would be removed by the leachate collection system. Lastly, the bottom double-liner would contain the leachate prior to removal. Records on the performance of RCRA landfills are limited because few landfills were built to such standards until a few years ago. The most critical factor for performance of a RCRA landfill would be the integrity of the liners. This integrity largely depends on construction quality control and leachate and liner compatibility, particularly for the bottom liner. Even with stringent quality control and extensive leachate/liner compatibility testing, the long-term performance of a filled RCRA landfill in service environments remains uncertain.

2. Compliance with ARARs

Construction of the on-site landfill would have to comply with all the requirements of RCRA.

3. Reduction in Mobility, Toxicity and Volume

Although an ideal RCRA landfill could effectively contain the waste over the design life, this technology would not offer a permanent solution of reducing the volume, toxicity or mobility of the waste. Air emissions during the construction period could cause a risk to the public health and environment for several months.

4. Reliability

A RCRA landfill would require a significant level of inspection and maintenance over it's entire active life. Inspection/maintenance items would include correction of settlement, erosion, grass cover, surface ponding, leachate removal, and ground water monitoring. Because of the very short application history, the reliability of a RCRA landfill is unknown and will be unknown for a few more decades.

B. Implementability

1. Technical Feasibility

RCRA permitting personnel from Region III compared the Tyson's Site characteristics and location to their RCRA locational guidances. The determination was made that it was highly unlikely that a RCRA landfill would be permitted at the Tyson's site location, for the disadvantages indicated as "critical factors" in the EPA Record of Decision. These "critical factors" include the following:

a. Protected lands - Tyson's Site is situated in close proximity to a wetlands.

b. Ground water monitoring - Due to fractured bedrock, contaminant releases may not be monitorable.

c. Ground water vulnerability - Target areas (wetlands and drinking water intakes) may be at risk.

d. Time to achieve remediation - Long time to achieve remediation.

Alternative 5 - Excavation/Off-Site Disposal, Leachate (Seep/Spring) Water Collection and On-Site Treatment

This remedial action alternative was selected by EPA in the December 1984 Record of Decision (ROD). The objective of soil excavation was to remove the contaminated soils and transport them to a secure RCRA approved landfill for disposal. Initially, soils known to be contaminated are excavated for disposal. Soil borings and soil analysis are conducted during the removal process to determine additional contaminated soils. Clean soils are stockpiled during excavation to provide backfill material and stabilize slopes in the excavation area. A chemical additive is then added to contaminated soils to remove free water prior to disposal. Finally, the dewatered soils are transported to an EPA-approved landfill that meets the RCRA minimum technology requirements for a double liner and double leachate collection system (Subtitle C landfill). Backfill material is then used to fill the excavated area to its former elevation or to predetermined elevations.

Leachate from the site and seep/spring water would be collected by an interceptor trench and routed to treatment units consisting of air strippers with carbon adsorption units. It was envisioned that these treatment systems would be erected on the south side of the railroad tracks.

The volume of contaminated soils to be removed is estimated to be 27,300 yard^3, based on EPA's latest studies at the site. An estimated 6040 yard^3 of cementitious material would be added to the soils to remove free water prior to transport off-site. Swelling of soils resulting from excavation was estimated to contribute 4095 yard^3 of additional volume to the materials removed from the site, for a total of approximately 37,000 yard^3.

An estimated 20,200 yard^3 of excavated soils without significant organics content would be stockpiled to provide backfill material and to stabilize slopes within the excavation area.

The EPA ROD stipulated that soils excavated from this area must be disposed in full accordance with RCRA regulations, including the requirement that they be sent to a Subtitle C landfill for disposal. A Subtitle C landfill is one with a double liner and a double leachate collection system.

A. Effectiveness

1. Protectiveness

Removal of contaminated materials is a highly effective, permanent (useful life) solution to prevention of 1)hazardous substances' migration off-site and into ground water, and 2) direct contact exposure with contaminated soils. It is highly reliable and has been successfully demonstrated at previous sites and requires little or no operation and maintanence.

Air emission controls and surface water run-off controls would have to be implemented during the design phase to minimize any organic vapor releases. However, a temporary evacuation plan for local residents in the event of a release and other safety measures could adequately address these concerns.

The continued operation of the leachate (seep/spring) collection system would provide long term management and control of contaminant flow from any shallow aquifer system.

2. Compliance with ARARs

This Alternative would have to satisfy the ARARs in accordance with RCRA Closure and Post-Closure requirements contained in (40 CFR 264). Other ARARs that may apply to the remediation of the soils in the former lagoon area via excavation and disposal are the National Ambient Air Quality Guidelines.

3. Reduction in Mobility, Toxicity or Volume

Excavation and off-site disposal of contaminated soils, fill material, and wastes to a permitted RCRA landfill would eliminate the continued generation and off-site migration of leachate from the former lagoon locations and the continued contamination of the ground water zones. During excavation of the soils, mobility of soil contaminants may be increased from volatilization. Volatilization controls would have to be implemented during excavation to control this potential problem. The result of excavation and off-site disposal would be the transferral of the contaminant mass to another land disposal facility without further reduction in toxicity and mobility.

4. Reliability

Excavation and off-Site disposal is highly reliable in removing contaminated soils. Minimal operations and maintenance requirements would be envisioned following completion of soil removal, assuming provisions for controlling site soil erosion and run-off were made. As with some soil excavations down the bedrock, unless precautionary measures are implemented, the potential may exist for recontamination of the backfilled soils from organic vapors diffusing upward from the contaminated bedrock.

Leachate (seep/spring) collection and treatment has proven to be effective in reducing contaminants in water.

B. Implementability

1. Technical Feasibility

Short-Term

Excavation of soils would be a technically feasible alternative, even though the site has limited area for maneuvering equipment. Conventional earth moving equipment would be able to operate on the site and near the quarry high wall provided that appropriate safety measures were taken. Such safety precautions would include improvement of the site access road, inspection of slope stabilities, and the construction of stable slopes where needed.

This alternative would require the availability of sufficient daily Subtitle C landfill capacity to allow disposal to keep pace with excavation. An appropriate Subtitle C landfill is one the EPA has authorized to accept wastes from Superfund sites and which has a double liner and double leachate collection system, as required by the ROD. The daily capacity of the receiving facility must be identified since the temporary stockpiling of excavated soils waiting for available landfill capacity could potentially pose unacceptable risks to the community and environment.

Long-Term

The excavation alternative would not limit any future remedial action should the excavation alternative fail, such as re-excavation, on-site treatment, in-situ treatment, or any ground water remediation. Also, this alternative would not prevent any necessary on-site or off-site ground water and soil monitoring. Long-term maintenance, consisting primarily of soil monitoring for recontamination, could be performed.

Offsite Incineration Alternative

Offsite incineration of the excavated materials was investigated in formulation of the 1984 ROD, but due to the limited availability of commercial facilities, the time required to process the materials (minimum three years - no staging of wastes at incinerator) and the lowest cost obtained ($21 million, just for incineration), it was decided that the landfill alternative was more feasible and cost effective.

A recent cost estimate developed in Region III's Bruin Lagoon ROD (September 26, 1986) calculated, using 1986 dollars, that offsite incineration for approximately 17,000 cubic yards of contaminated material would cost in the range of $100 to $202 million. Because of these high project costs and the estimated long timeframe for implementation, this alternative was not selected for further evaluation.

Innovative Technology Remedial Action Alternative

Alternative 6 - Vacuum Extraction of Contaminated Soils

The vacuum extraction process is an in-situ treatment process used to clean soils that contain volatile compounds. The process utilizes extraction wells to induce a vacuum on subsoils that are above the water table. Subsurface vacuum propogates laterally, causing in-situ volatilization of compounds adsorbed to soils. Volatilized compounds and subsurface air migrate rapidly to extraction points and are then passed through and collected on activated carbon substrate. Figure 2 shows a conceptual design for the vacuum extraction process.

A. Effectiveness

1. Protectiveness

This alternative is designed to reduce the level of contaminants in the former lagoon areas and to reduce the potential risks to public health, site workers and the environment. The alternative would combine the leachate (seep /spring) water collection and treatment system, vacuum extraction for soil remediation, and remediation of the residual, dense, non-aqueous, phase liquid (DNAPL) in the unsaturated

VACUUM EXTRACTION SYSTEM

TYSON'S SITE, PENNSYLVANIA

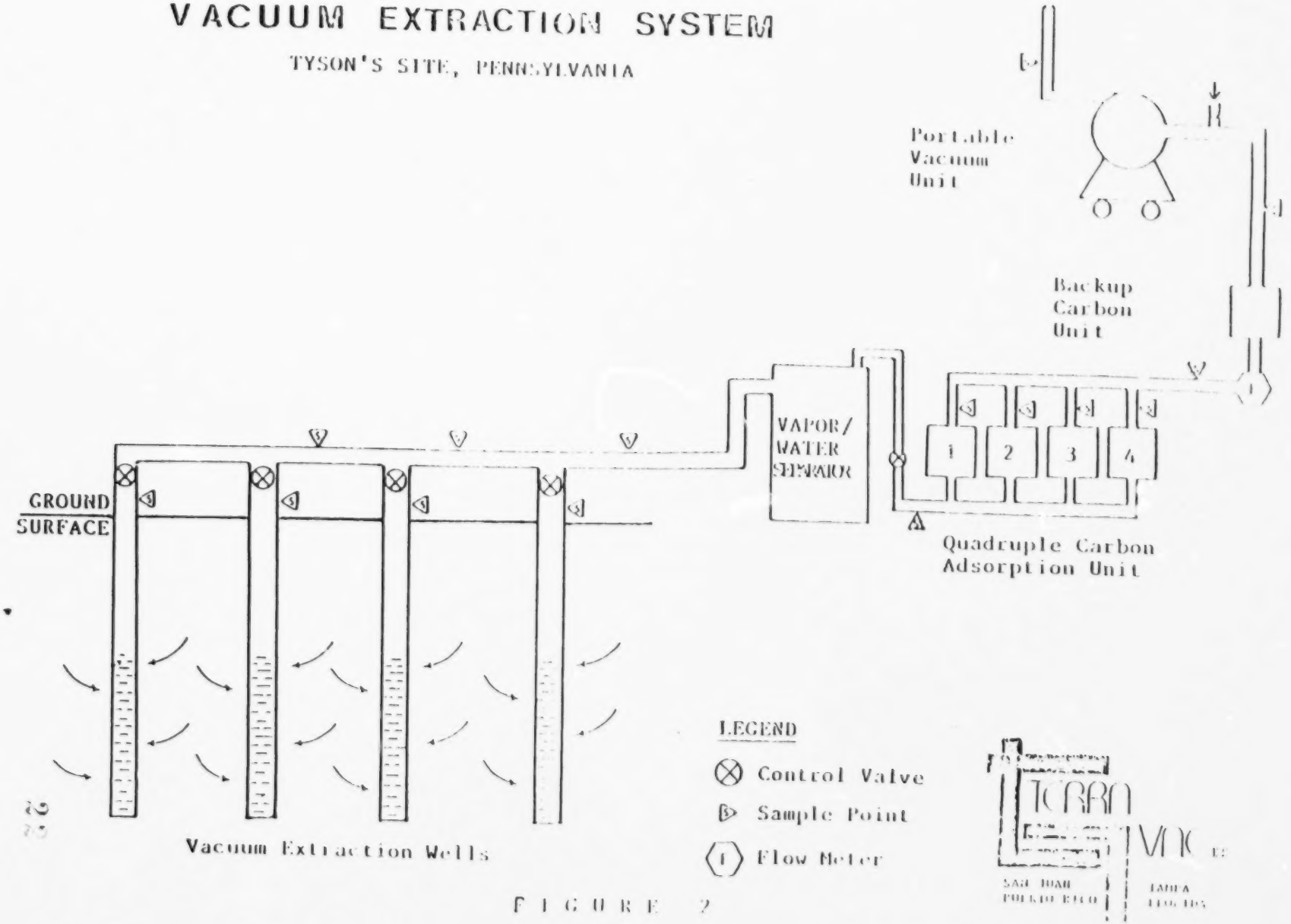


FIGURE 2

bedrock beneath the former lagoon area. Remediation of the soils and unsaturated bedrock eliminates the need for a soil cap meeting RCRA performance standards. Control of surface infiltration or DNAPL vapor movement by a clay/bentonite and/or impermeable layer would not be required. The soil cover would be installed at the conclusion of vacuum extraction.

The vacuum system would extract any perched ground water and volatile compounds from the soil column and residual DNAPL from the unsaturated zone beneath the former lagoons. The vacuum-extracted water would be treated by the on-site leachate (seep/spring) water treatment system.

2. Compliance with ARARs

The EPA Feasibility Study and subsequent Record of Decision determined that because it was technically infeasible to cap the site due to the high quarry wall and the ground water was not monitorable, in accordance with the performance standards for RCRA Landfill Closure, as established in (40 CFR Part 264), contaminated soils exceeding background levels needed to be remediated down to background levels or excavated and disposed off-site. In March 19, 1987, EPA proposed an amendment to this closure requirement (52 Fed. Reg. p.8712 et.seq.) which would allow contaminants to remain on-site if it can be shown that any wastes and waste residues remaining on site will not pose a threat to human health and the environment through any potential exposure pathway. These potential pathways include exposure to the waste constituents through direct contact, ground water, surface water, and atmospheric routes. This proposed rule making would serve as the RCRA ARAR which vacuum extraction would have to meet. Under this proposed rule, safe soil criteria would need to be developed for vacuum extraction to attain, for this alternative to be in compliance and acceptable to EPA.

Other possible ARARs that may apply to a vacuum extraction operation and the water treatment would be the Ambient Air Quality Guidelines established under the Pennsylvania Interim Operating Guidance for Air Toxics Substances. Both operations would satisfy these possible ARARs. Interim status RCRA standards of closure, post closure care, and monitoring may also apply to the alternative.

3. Reduction in Mobility, Toxicity and Volume

Vacuum extraction is expected to significantly reduce the volume of contaminants in the soil. However, since this technology has not been readily applied to other similar sites it can only be estimated through pilot scale tests and modeling that this technology will attain the levels determined by the Agency to be protective of human health and the environment.

3. Reliability

Recent studies have shown that vacuum extraction has a record of success in achieving very significant VOC recoveries from soils, and some documentation indicate that vacuum extraction can remove VOCs from 90 percent to 99 percent (USATHAMA 1985; Malot and Wood 1985; Malot 1984; Payne et al. 1986; Agrelot et al. 1984; and Weston 1986).

The results of the vacuum extraction pilot test at the Tyson Site in May 1987 indicated that significant reductions in the mobility and volume of VOCs in the contaminated soils and unsaturated bedrock are achievable. Additionally, it was found that vacuum extraction also removed significant amounts of semi-volatile compounds including one of the predominant site specific compounds, 1, 2, 3-trichloropropane.

Four vacuum extraction wells installed to the top of bedrock achieved recovery rates of approximately 90 lbs/day of total VOCs and a radius of influence of 40 feet; a single vacuum extraction well installed in unsaturated bedrock recovered 16 lbs/day of total VOCs and exhibited a significant radius of influence. Permanent reduction in toxicity would occur during fume incineration of the off-gases from the vacuum extraction system.

B. Implementability

1. Technical Feasibility

To date, numerous pilot and full-scale vacuum extraction systems have been constructed at sites consisting of a variety of soil types ranging from fine, sandy soils to sandy loam soil to clayey silt and silty clay soils. The depth to ground water in these projects varied. At one site, vacuum extraction was successfully operated in fractured limestone.

The installation and operation of a vacuum extraction system would not limit additional remediation at the Tyson's Site. The vacuum manifold, vacuum blowers, and fume incineration equipment or carbon tanks could be removed relatively easily to allow for implementation of another on-site or in-situ treatment, if required.

The actual vacuum extraction apparatus would require very little maintenance. Sufficient soil testing would be required to verify the achievement of acceptable residual contaminant levels in the soil. Ground water monitoring would be required after completion of the vacuum extraction.

The time required for full-scale vacuuming to achieve the desired soil remediation for projects documented in the literature ranges from between six weeks to more than one year. At the Twin City Army Ammunition Plant (TCAPP) site, over 60,000 lb. of tetrachloroethene have already been recovered by vacuum extraction after only one year of operation, and the operation will be continued for some time (TCAAP Operations Manger 1986). Under continuous operation, allowing for start-up, weather, and water table conditions, the responsible parties have estimated from their data that it would take two years of operation for acceptable remediation of the Tyson's former lagoon area soils.

Recommended Alternative

Section 121 of the Superfund Amendments and Reauthorization Act of 1986 (SARA) and the current version of the National Contingency Plan (NCP) (50 Fed. Reg. 47912, November 20, 1985) established a variety of requirements relating to the level of cleanup for remedial actions under CERCLA. Applying the current evaluation criteria (effectiveness, implementability, and cost) that was previously described for each of the alternatives, EPA is recommending that Alternative 6 be implemented at the Tyson's Dump Site. This innovative technology remedial action alternative meets the goals of SARA: protection of human health and the environment; attainment of possible ARARs through treatment and contaminant recovery in both the lagoon area soils and in the unsaturated bedrock underlying the former lagoon area; achievement of permanent reduction in waste volume and toxicity on-site; and control of potential migration of contaminants by use of leachate (seep/spring) collection and treatment system. A disadvantage of this alternative is that trace levels of metals and nonvolatile organic compounds, which have been shown not to present a risk to human health and the environment, may remain on-site. This alternative is not the least expensive of all the feasible alternatives considered, but is one of the most cost-effective of the alternatives that are protective of human health. Table 1 summarizes the associated costs for each alternative.

Alternative 5 (Excavation and Off-Site Disposal of Contaminated Soils) is designed to provide a permanent solution to the risks associated with the site. This Alternative also provides ease of implementation and has a proven performance in removing contaminated soil volumes. Some of the disadvantages of Alternative 5 include: greater potential release of volatile organic vapors to the community; inability to remove contaminant levels in the bedrock underlying the lagoon soils; the intent of SARA which discourages excavation and transference of contamination from one source to another; and the high cost of disposal.

Alternative 1 was not selected because it would not be protective of human health and the environment. Alternatives 2 and 3 were not selected because they are technically infeasible and also are not protective of human health and the environment.

TABLE 1

Summary of Cost Estimates for Remedial Action Alternatives at Tyson's Dump Site

Alternatives	Total Estimated Costs
1. No action	(1) 485,720
2. Site Capping and Ground water Diversion	(1) 3,680,860
3. Ground water/Leachate Collection and Treatment and Surface Sealing	(1) 2,053,475
4. Construction of an On-site Secure Landfill	(1) 2,941,434
5. Excavation and Off-site Disposal; including leachate collection and treatment	(2) 20.8 million
6. Vacuum Extraction; including leachate (seep/spring) collection and treatment and soil cover.	(3) 10.2 million

(1) Updated Costs of the 1984 EPA ROD using the Department of Commerce Gross National Product Deflator factor of 1.082 (2nd Quarter 1987).

(2) Costs developed from EPA Final Design 9/87.

(3) Responsible Parties June 16, 1987 Comprehensive Feasibility Study.

The Total Estimate Costs for each Alternative include long-term operation and maintenance.

EPA's Recommended Innovative Remedial Action Alternative Implementation

The following is an explanation of EPA's Recommended Alternative that may be implemented by the Responsible Parties (RPs), under the supervision of EPA, utilizing the proposed Innovative Technology Remedial Action Alternative Number 6. Additionally, RPs may also implement ground water corrective measures.

Summary of Remedial Measures and Settlement for the Tyson's Site

1. Responsible parties (RPs) are to cleanup lagoon soils to a 50 part per billion level for four indicator organic compounds and also to clean lagoon soils of other organics to levels determined by the Agency to be protective of human health and environment. The lagoon cleanup levels for the lagoon soils are listed in Table 2. These levels have been determined in accordance with the methodologies as set forth in Appendix A.

2. At the end of the twelve months of vacuum extraction the RPs will determine the effectiveness of the cleanup and by the end of a twenty-six month period attain the cleanup levels specified by EPA. If target levels are not attained by the RPs within the first year, the RPs will address supplemental measures to improve the vacuum extraction process. At the end of a period not to exceed two years and two months from start of vacuum extraction, RPs must verify attainment of specified process levels or EPA may require RPs to remove soils for offsite treatment or disposal, or to implement any other response action.

3. RPs to implement ground water remediation at river locations proposed in the RPs' Comprehensive Feasibility Study and to establish compliance points at the river locations as well as to establish compliance points at the lagoon boundaries, for the attainment of cleanup standards for site related compounds. The final remedy selected for such ground water remediation will implement all applicable or relevant and appropriate requirements in consultation with the Commonwealth of Pennsylvania and such standards will be included in a ROD developed subsequent to the completion of the Off-Site Operable Units Remedial Investigation/Feasibility Study.

4. RPs are to develop Design Work Plan subject to EPA approval prior to start of any site work.

5. RPs are to take over full operation and maintenance of leachate collection system and stripper and upgrade air stripper to deal with expected leachate (seep/spring) and ground water flow.

6. RPs are to remediate contaminants in the tributary from the existing stripper effluent areas to the Schuylkill River.

7. RPs are to develop long-term O&M Work Plan and implement this plan for lagoon area subject to EPA approval.

8. RPs are to reimburse EPA $2.3 million and State $141 thousand which are past costs for response actions at the Tyson's Site.

Table 2

CLEANUP LEVELS FOR LAGOON SOILS

Compound	Concentration in mg/kg
Aniline	1.40 E +00
Anthracene	1.24 E +04
Benzene	0.05 E +00
Benzoic Acid	6.95 E +00
Bis(2-ethylhexyl)Pthalate	8.31 E +04
2-Butanone	3.68 E +01
Chlorobenzene	1.15 E +01
2-Chloronaphthalene	1.70 E +02
2-Chlorophenol	3.80 E +00
Chrysene	6.00 E -02
Cycloheptatriene	2.10 E -01
Cyclohexanone	2.62 E +02
Di-N-ButylPhthalate	8.94 E +02
Di-Octyl Phthalate	1.64 E +04
Dichlorobenzenes	6.00 E +01
2,4-Dimethylphenol	1.08 E +01
N,N-Dimethyl-1,3-Propanediamine	6.50 E +00
Dodecane	4.90 E +05
Ethylbenzene	5.99 E +02
1-Ethyl-2-Methylbenzene	1.07 E +02
Fluoranthene	4.08 E -02
Hexadecane	2.90 E -06
Hexadecanoic Acid	1.97 E -01
Methylene Chloride	5.84 E +00
2-Methylnapthalene	4.78 E +02
2-Methyl Phenol/4-Methyl Phenol	3.35 E +01
2-Methyl-2-Pentanone	1.87 E +01
N-Nitrosodiphenylamine	4.80 E +00
Naphthalene	3.03 E +02
Nitrobenzene	3.00 E -01
1,1-Oxybis-(2-ethoxyethane)	9.22 E +00
Phenanthrene	7.09 E +02
Phenol	4.19 E +01
Pyrene	3.89 E +03
Tetrachloroethene	0.05 E +00
Tetramethylurea	7.50 E +00
Toluene	5.88 E +02
1,2,4-Trichlorobenzene	4.79 E +02
1,3,5-Trichlorobenzene	4.79 E +02
Trichloroethene	0.05 E +00
1,2,3-Trichloropropane	0.05 E +00
1,2,4-Trimethylbenzene	1.23 E +03
Tridecane	5.40 E +04
Undecane	2.30 E +04
O-xylene	6.28 E +01

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1. Off-Site Operable Unit Remedial Investigation Report, (July 30, 1987) Volumes I through V.

2. EPA's Record of Decision, December 1984.

3. June 16, 1987 letter from Karline Tierney of Ciba-Geigy Corporation to Mr. Stephen Wassersug of EPA.

4. June 16, 1987 Comprehensive Feasibility Study (Volumes I through III) generated by ERM Inc. for Ciba-Geigy Corp..

5. July 24, 1987 letter from Karline K. Tierney of Ciba-Geigy Corporation to Mr. Stephen Wassersug of EPA.

6. Federal Register, Thursday March 19, 1987, Part III (Proposed Amendments for Landfill, Surface Impoundments, and Waste Pile Closures; Proposed Rule).

FILE: 272-14

CALCULATION OF CLEANUP LEVELS FOR THE FORMER LAGOON AREA TYSON'S SITE

30 November 1987

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Introduction

The cleanup of the former lagoon area at the Tyson's Site will include the extraction of contaminants from the soil. Because there are no specific levels stated in the law for cleanup of soil, it was necessary to develop soil cleanup levels for this site for purposes of this consent decree. The cleanup levels developed here represent levels determined to be protective of human health at the completion of the cleanup of the soils.

EPA has specified cleanup standards of 50 parts per billion for four chemicals (1,2,3-trichloropropane, benzene, trichloroethene, and tetrachloroethene). EPA has also specified a list of other contmainants for which cleanup levels had to be calculated.

To calculate appropriate soil cleanup levels, this document first identified health-based acceptable intake levels for each contaminant. The health-based acceptable intake levels include large safety factors or highly conservative assumptions and thus represent fully protective levels.

The soil levels necessary to achieve the acceptable intake levels were then calculated using hypothetical exposure scenarios. The exposure scenarios were selected by EPA in cooperation with ERM and were intended to result in soil levels that would be fully protective of human health. The selected scenarios include:

- a hypothetical well at the boundary of the site, assuming that any residual soil contamination is released into the ground water from which the well draws, and assuming a lifetime of exposure to the water from the well for all uses;

- potential construction of a road through the site in the future after the cleanup, assuming that soils are unearthed and construction workers are exposed to contamination by inhalation of dusts or vapors, dermal exposure, and ingestion of soil with no hygienic or protective measures;

- assuming that road construction occurs and the cover over the site soils is not replaced (an unlikely event), potential exposure by children playing in the area where the soil has been disturbed, assuming exposure over a six-year period via inhalation of dusts, ingestion of soil on hands, and dermal absorption.

Each of the scenarios includes a number of conservative assumptions, and these scenarios are not expected to occur or to occur on a continuing basis. (Each of the scenarios addresses hypothetical exposure after the cleanup is complete; during the cleanup the site will be secured and under guard, so that exposures to the public are precluded.)

Once the calculations were done for each of the exposure scenarios, the scenario producing the most stringent cleanup requirement was selected as the cleanup level. In almost every instance, the most stringent level was generated under the scenario that assumes that soil contamination gives rise to ground water contamination and that a residential well drawing only this contaminated ground water is used for all household purposes for a lifetime. The scenarios addressing exposure of construction workers or children playing at the site would have required less stringent cleanup levels.

The methodology underlying the calculations in this document is designed to produce stringent cleanup standards that are fully protective of human health.

Purpose

The vacuum extraction remedy for the On-Site Operable Unit (former lagoon area) at the Tyson's Site is designed to attain cleanup levels of 50 ppb in soils for the compounds 1,2,3-trichloropropane, benzene, trichloroethene and tetrachloroethene, as stipulated in the consent decree. However, no target concentrations for residual levels of other chemical contaminants identified during on-site investigations had been established.

The purpose of this effort was to establish quantitative cleanup levels for certain specified chemicals in the soils in the former lagoon area at the Tyson's Site. These cleanup levels are based on public health considerations due to contact with contaminants at potential population exposure points.

The development of cleanup levels for contaminants in soils in the former lagoons involved identification of exposure scenarios, definition of acceptable intake levels for each contaminant at various population exposure points, and calculation (via backward modeling) of the corresponding soil concentrations that would result in acceptable limits of exposure. The process can be separated into the following components:

1. Identification of potential and reasonable exposure pathways or circumstances (i.e., characterization of likely exposure points).

2. Determination of acceptable intakes for each chemical over the duration of each of the identified exposure pathways or scenarios.

3. Quantitative estimates of the release rates and/or relationships between concentrations in on-site soils and concentrations at points of human exposure for each identified exposure scenario (e.g., transport modeling).

4. Quantitative assessment of the likely chemical intakes resulting from contact at exposure points.

5. Integration of the preceding factors to back-model from an acceptable intake to a corresponding acceptable soil concentration for each chemical for each of the potential exposure scenarios considered.

Performance goals were then defined by selecting the lowest soil concentration calculated under the exposure scenarios examined.

Identification of Potential Exposure Points and Summary of Exposure Scenarios

Because the remedial action includes installation of a clean surface cover upon completion of vacuum extraction, and the securing of the site (fencing) during the remediation, direct contact and emissions of contaminated dust are precluded. However, ground water contamination resulting from contaminants present in subsurface soils following vacuum extraction is a plausible scenario. Accordingly, contamination of a hypothetical potable well installed at some future time at the boundary of the former lagoons (on-site operable unit) is considered here. The migration of subsurface soil contaminants into the underlying ground water, which then migrates to the location of the hypothetical well, is calculated using EPA's RITZ model and is presented in detail in Appendix A.

Users of this hypothetical well were assumed to ingest 2 liters (L) per day of contaminated water for a lifetime of 70 years. For the purposes of this scenario it is assumed that some ground water contaminants arising from contaminated soil would be highly volatile. Such contaminants thus could transfer during use from household water to indoor ambient air and be inhaled. Dishwashing, laundering, cleaning, etc, may result in release of volatile contaminants into surrounding indoor air which is assumed to exchange with outdoor air on an average frequency of once per hour (Pritchard and Gesel, 1985). As discussed in the endangerment assessment for the off-site operable unit (ERM, 1987), inhalation of indoor air is not a significant pathway for exposure relative to drinking 2L/day of the contaminated water. The exception is inhalation of contaminants during showering in an unventilated bathroom. Inhalation exposure to volatile organics under this scenario is considered in Appendix B-1.

In addition to the lifetime exposure from the hypothetical use of contaminated well water, it is considered possible that a road may be constructed in the future through portions of the site. This activity could be expected to unearth contaminated soils which are then assumed to be spread upon portions of the work area surface. Road construction work crews could be exposed to contaminated soils via inhalation of dusts, dermal absorption, and incidental ingestion of contaminated soils for a period not greater than 30 days (6 weeks at 5 days per week). In addition to the subchronic exposure to soil, a worker could be acutely exposed to volatiles rapidly released into the ambient air by uncovering contaminated soils during bulldozing or grading activities. Thus, acute exposure to vapors was also considered in the analysis.

Under the conditions of road construction through areas of subsurface contamination, it is assumed that workers may incidentally ingest about 90 mg of soil per day, inhale and subsequently swallow about 4 mg of dust per day, and absorb through the skin the amount of contaminant contained in 36 mg of soil. The assumptions, calculations, and available documentation for these estimated intake levels are presented in detail in Appendix B-2. Those assumptions presume that workers do not take protective or hygienic measures.

The scenario assumes that no new, clean cover material (other than the blacktop) is reapplied to the disrupted, previously covered area of contamination after the road is constructed and the work crew moves on, an opportunity for adventurous children to enter the site could create an additional exposure scenario. It should be noted however, that the consent decree stipulates the presence of a suitable cover on the site. In all likelihood, if a road were constructed through the former lagoons, a "new" cover would be applied to all disturbed surfaces on either side of the asphalt roadway. However, for the purpose of determining whether such an exposure scenario could represent the most restrictive cleanup levels and to ensure minimal risks to trespassing children, it is assumed for purposes of calculation that children could gain free access to areas where subsurface soil contamination has been uncovered and brought to the surface.

In this circumstance, it is assumed that adventurous children (6 to 12 years of age) may ingest 50 mg of contaminated soil; inhale, retain, and subsequently absorb (largely by swallowing) 0.15 mg of contaminated soil; and dermally absorb the amount of contaminants contained in about 8 mg of soil that may adhere to exposed skin for each visit to the areas of highest contamination on this site. The duration of the typical visit, the frequency of visits and the span of years during which a child is likely to play in the area are all factored into this scenario to determine representative chronic intake coefficients which are then compared to acceptable chronic intake levels (child) used to derive corresponding "acceptably safe" soil concentrations. Details concerning the several assumptions, the calculations of estimated intakes of contaminated soils, and the available and relevant support documentation are presented in Appendix B-3.

Determination of Acceptable Intake Levels

Acceptable levels (or intakes) for each chemical of concern for each of the identified exposure pathways or scenarios are presented in Table 1 with documentation of their source. The decision logic utilized to select the most appropriate standard or guideline or to develop acceptable intake levels is presented in Appendix C.

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Calculation of Soil Cleanup Levels

The soil cleanup levels calculated for each chemical of concern for each of the identified exposure pathways or scenarios are presented in Table 2. Except for the four compounds for which cleanup levels were selected by EPA, the lowest calculated soil level for a chemical of concern for the various exposure scenarios is selected as the cleanup level for that chemical.

Site Types
Date prepared 11 November 1987 (TAS)

TYSONS SITE

ACCEPTABLE LEVELS AND PHYSICAL/CHEMICAL CONSTANTS

CHEMICAL	Subchronic acceptable daily intake mg/kg/day	SOURCE	Chronic acceptable daily intake mg/kg/day	SOURCE	Air Dilution coefficients g-j m/day	Water Solubility mg/l	Henry's law constant
ANILINE	3.0E-02	AIC * 10	3.0E-03	AIC	8.68E-01	3.40E+04	1.55E-04
ANTHRACENE	2.0E+00	[ORAL]/10,000 (MEDICINE)	2.0E-01	[ORAL]/100,000 (MEDICINE)	8.19E-01	4.00E-02	3.39E-02
BENZENE V	CR	SPHEM CPF	CH	SPHEM CPF Inhalation	7.17E-01	1.78E+03	2.30E-01
BENZOIC ACID	2.0E-01	[ORAL]/10,000 (MEDICINE)	2.0E-02	[ORAL]/100,000 (MEDICINE)	8.14E-01		1.00E-06
BIS(2-ETHYLHEXYL)PHTHALATE	CR	SPHEM CPF	CH	SPHEM CPF	4.19E-01	4.00E+00	1.30E-06
2-BUTANONE	6.0E-01	SPHEM AIC * 10	6.0E-02	SPHEM AIC	7.80E-01	2.68E+06	1.18E-03
CHLOROBENZENE V	2.7E-01	SPHEM AIS	2.7E-02	SPHEM AIC	7.60E-01	4.68E+02	1.55E-01
2-CHLORONAPHTHALENE	8.0E-02	mouse [D60/10,000 (MEDICINE)	8.0E-03	mouse [D60/100,000 (MEDICINE)	8.70E-01	8.74E+00	2.31E-02
2-CHLOROPHENOL	2.0E-02	[Reference 2]	2.0E-03	[Reference 2]	7.48E-01	2.85E+04	4.30E-06
CHRYSENE *	CR	SPHEM CPF (BaP * 2)	CH	SPHEM CPF [PAH Inhalation]	8.78E-01	1.90E-03	8.30E-04
CYCLOHEPTATRIENE *	8.7E-03	[D60 / 10,000 (MEDICINE)	8.7E-04	[D60 / 100,000 (MEDICINE)	1.10E+00		1.00E-03
CYCLOHEXANONE	2.0E+01	ADI * 10	2.0E+00	AIH	8.58E-01		1.10E-02
DI-N-BUTYL PHTHALATE	1.0E+00	SPHEM AIC * 10	1.0E-01	SPHEM AIC	4.19E-01	1.30E+01	1.20E-06
DI-OCTYL PHTHALATE	1.0E-01	ADI * 10	1.0E-02	AIH	4.19E-01	3.00E-01	7.10E-04
DICHLOROBENZENES V	8.9E-01	[Reference 4]	8.9E-02	[Reference 4]	7.40E-01	1.01E+02	1.63E-01
2,4-DIMETHYLPHENOL	8.0E-02	LD50 /10,000	8.0E-03	LD50 / 00,000	7.98E-01	8.80E+02	2.19E-04
N,N-DIMETHYL 1,3-PROPANEDIAMINE	1.0E-01	[D60 / 10,000 (MEDICINE)	2.0E-02	[D60 / 100,000 (MEDICINE)	8.48E-01		1.00E-03
DODECANE	1.1E+00	[OLO percutaneous/10,000 (MEDICINE	1.1E-01	[OLO percutaneous/100,000 (MEDICINE			
ETHYLBENZENE V	9.7E-01	SPHEM AIS	1.0E-01	SPHEM AIC	8.24E-01	1.62E+02	2.88E-01
1-ETHYL-2-METHYLBENZENE	1.0E-01	same as xylene	1.0E-02	same as xylene	nonvolatile	1.78E+02	1.00E-03
FLUORANTHENE	8.0E-02	ADI * 10	8.0E-03	AIH	8.87E-01	2.60E-01	6.50E-04
HEXADECANE	8.4E+00	[OLO percutaneous/10,000 (MEDICINE	8.4E-01	[OLO percutaneous/100,000 (MEDICINE			
HEXADECANOIC ACID	8.7E-02	[D60 intravenous/10,000 (MEDICINE]	8.7E-04	[D60 intravenous/10,000 (MEDICINE]	8.44E-01		1.00E-03
METHYLENE CHLORIDE V	CH	SPHEM CPF	CH	SPHEM CPF	8.45E-01	2.00E+04	8.83E-02
2-METHYLNAPHTHALENE	1.6E-01	[D60 / 10,000 (MEDICINE)	1.6E-02	[D60 / 100,000 (MEDICINE)	7.12E-01		1.00E-03
2-METHYLPHENOL(O-CRESOL)	8.0E-01	SPHEM AIC*10	8.0E-02	SPHEM AIC	8.00E-01	2.19E+04	2.28E-04
4-METHYL-2-PENTANONE	8.0E-01	SPHEM AIC * 10	8.0E-02	SPHEM AIC	8.44E-01	1.70E+04	1.10E-04
N-NITROSODIPHENYLAMINE	CH	ECAO CPF	CH	ECAO CPF	8.03E-01	4.00E+01	1.00E-03
NAPHTHALENE V	8.3E-01	[Reference 6]	8.3E-02	[Reference 6]	7.40E-01	3.17E+01	1.00E-02
NITROBENZENE	8.0E-03	SPHEM AIC * 10	8.0E-04	SPHEM AIC	7.68E-01	1.90E+03	3.69E-02
1,1'-OXYBIS(2-ETHOXYETHANE)	2.4E-01	[D60 / 10,000 (MEDICINE)	2.4E-02	[D60 / 100,000 (MEDICINE)	8.27E-01		1.03E-03
PHENANTHRENE	7.0E-02	[D60 / 10,000	7.0E-03	[D60/100,000	8.61E-01	1.00E+00	8.10E-03
PHENOL	1.0E-01	SPHEM AIS	1.0E-02	SPHEM AIC	8.78E-01	8.30E+04	1.90E-05
PYRENE	2.0E-01	[Reference 6]	2.0E-02	[Reference 6]	8.07E-01	1.30E-01	2.13E-04
TETRACHLOROETHENE V	CH	SPHEM CPF	CH	SPHEM CPF Inhalation	8.44E-01	1.50E+02	1.90E+00
TETRAMETHYLUREA	2.2E-01	[D60 / 10,000 (MEDICINE)	2.2E-02	[D60 / 100,000 (MEDICINE)	8.48E-01		1.00E-03
TOLUENE V	4.3E-01	SPHEM AIS	3.0E-01	SPHEM AIC	8.30E-01	6.35E+02	2.84E-01
1,2,4-TRICHLOROBENZENE	2.0E-01	SPHEM AIC * 10	2.0E-02	SPHEM AIC	8.19E-01	3.00E+01	1.32E-01
1,3,5-TRICHLOROBENZENE	2.0E-01	SPHEM AIC * 10 (1,2,4 ISOMER)	2.0E-02	SPHEM AIC (1,2,4 ISOMER)	8.78E-01		1.32E-01
TRICHLOROETHENE V	CH	SPHEM CPF	CH	SPHEM CPF Inhalation	7.48E-01	1.10E+03	3.80E-01
1,2,3-TRICHLOROPROPANE V	CR	EPA CPF	CH	EPA CPF	8.31E-01	2.00E+03	1.40E-02
1,2,4-TRIMETHYLBENZENE	8.6E-01	adjusted TLV / 10	8.6E-02	adjusted TLV / 100	7.60E-01		1.00E-03
TRIXENE	1.2E-01	[D50 intravenous/10,000 (MEDICINE]	1.2E-02	[D60 intravenous/100,000 (MEDICINE]			
UNITANE	6.2E-02	[D60 intravenous/10,000 (MEDICINE]	6.2E-03	[D60 intravenous/100,000 (MEDICINE]			
O-XYLENE V	1.0E-01	SPHEM AIS	1.0E-02	SPHEM AIC	8.11E-01	1.78E+02	2.03E-01

KEY (SEE APPENDIX C FOR EXPLANATION)

(CAO: ENVIRONMENTAL CRITERIA AND ASSESSMENT OFFICE OF THE EPA CINCINNATI (OH))
personal communication with Chris Dellinger at ECAO through Tim Timmins, Region III EPA (8/29/88)

ADI: ACCEPTABLE DAILY INTAKE

(LOLO: LOWEST TOXIC DOSE

AIC: ACCEPTABLE INTAKE CHRONIC EXPOSURE (

CPF: CARCINOGENIC POTENCY FACTOR

(LOLO: LOWEST LETHAL DOSE

AIS: ACCEPTABLE INTAKE SUBCHRONIC EXPOSURE (

MCLG: MAXIMUM CONTAMINANT LEVEL GOAL

(LD50: LETHAL DOSE WITH 50% KILL, USED IN CONNECTION WITH CHRONIC SAFETY FACTORS WHERE SUBSTANCE SPECIFIC DATA UNAVAILABLE

TLV: THRESHOLD LIMIT VALUE (ACGIH)

PEL: PERMISSIBLE EXPOSURE LEVEL (OSHA)

V: CRITERIA FOR DETERMINING VOLATILITY OF A COMPOUND IS A HENRY'S LAW CONSTANT GREATER THAN 0.01. THE DESIGNATED CO-"V"s (HOB ARE VOLATILES (X) FOR DRINKING AND INHALATION)

CR: BASED ON CANCER RISK, REFER TO TEXT.
ACCEPTABLE DAILY INTAKE - (EE 06 @ 000001) LIFETIME EXPOSURE RISK/TOTAL NUMBER OF DAYS EXPOSED

* For Groups A and B components, EPA stipulated that the CPF for Benzo(a)pyrene be applied to chrysene and increased by a factor of two (2) for other undetected Group A and B polycyclic aromatic hydrocarbons

MCL: MAXIMUM CONTAMINANT LEVEL

SPHEM: SUPERFUND PUBLIC HEALTH EVALUATION MANUAL 1988

MEDLINE: COMPUTER HOOK-UP WITH THE NATIONAL LIBRARY OF MEDICINE (RTECS UPDATE)

(Reference 1) Olgers, FW, Hackley, EB, Comstock, CC "Archives of Industrial Health" (13) p 379 1964

(Reference 2) Exon, JH and Koller, LD "Effects of transplacental exposure to chlorinated phenols" Env Health Perspectives 46 137-140 1982

(Reference 3) ECAO RfD "Verified Reference Dose (RfD) of the USEPA January 1988

(Reference 4) Hodgeworth, RI et al 1964 "Toxicology of o dichlorobenzene post operative studies on animals and industrial experience" Archives Industrial Health 17 180-187

(Reference 5) Shopp, GM et al 1984 "Naphthalene toxicity in cd mice General Toxicology and Immunotoxicology" Fundamental and Applied Toxicology 4 498-519

(Reference 6) White, J and A White 1930 "Inhibition of Growth of rat by oral administration of methylcholanthrene, benzopyrene, or pyrene and the effects of various dietary supplements" J. Biological Chemistry 121,199-101

TABLE 2

Site: Tyson's	TYSON'S SITE					
Date Prepared: 13 November 1987 (TAS)	ACCEPTABLE SOIL CONCENTRATIONS BASED ON VARIOUS SCENARIOS					
Date Checked: 15 November 1987 (DYH)	Concentrations in mg/kg					
	Residential Well Exposure	Acute Inhalation Exposure to Vapors by Road Construction		Subchronic Exposure to Soils by Road Construction	Chronic Exposure to Soils by Children (6-12) Near Road Construction	Subchronic Exposure to Soils by Children 6-12 after Road Construction
COMPOUND	EPA RMCL	Crew (1-2)		Crew (30 days)	9 years)	9 years)
ANILINE	1.40E+00	1.90E+05	PEL	2.0E+04	2.7E+05	1.9E+04
ANTHRACENE	2.90E+04	1.24E+04		1.1E+06	1.3E+06	3.0E+05
BENZENE (CA) V	3.70E+00	8.07E+00		9.1E+03	1.4E+03	1.4E+03
BENZOIC ACID	6.95E+00			1.1E+05	1.3E+05	3.0E+04
BIS(2-ETHYLHEXYL)PHTHALATE (CA)	8.31E+04	8.98E+05	PEL	6.9E+05	1.1E+05	1.1E+05
BROMOFORM	3.48E+01	6.45E+05	PEL	2.8E+05	3.2E+05	2.2E+05
CHLOROBENZENE V	1.15E+01	2.38E+03	PEL	1.5E+05	1.7E+05	1.2E+05
2-CHLORONAPHTHALENE	1.70E+02	8.15E+02		5.0E+04	5.7E+04	4.0E+04
2-CHLOROPHENOL	3.80E+00	1.27E+05		1.6E+04	1.8E+04	1.3E+04
CHRYSENE (CA)	8.00E+02	4.75E+02	TLV	2.1E+01	3.2E+00	3.2E+00
CYCLOHEPTATRIENE	2.10E+01	7.28E+02		3.2E+03	3.6E+03	2.5E+03
CYCLOHEXANONE	2.82E+02	2.13E+04	PEL	1.1E+07	1.3E+07	9.0E+06
DI-N-BUTYL PHTHALATE	8.34E+02	9.70E+05	PEL	5.9E+05	6.3E+05	4.5E+05
DI-N-OCTYL PHTHALATE	9.21E+03	1.84E+04		1.2E+06	1.4E+06	8.5E+05
DICHLOROBENZENES V	8.00E+01	2.80E+03	PEL	5.0E+05	5.9E+05	4.0E+05
2,4-DIMETHYLPHENOL	1.38E+01	2.08E+04	TLV	4.5E+04	5.0E+04	3.8E+04
N,N-DIMETHYL-1,3-PROPANEDIAMINE	8.50E+00	3.12E+04		1.0E+05	1.3E+05	8.4E+04
DODECANE	NOT MODELED			8.2E+05	9.3E+05	6.9E+05
ETHYLBENZENE V	5.99E+02	1.97E+03	PEL	5.4E+05	6.3E+05	4.3E+05
1-ETHYL-2-METHYLBENZENE	1.07E+02			5.6E+04	6.3E+04	4.5E+04
FLUORANTHENE	4.38E+02	3.12E+04	PEL	3.4E+04	3.8E+04	2.7E+04
HEXADECANE	NOT MODELED			3.6E+06	4.2E+06	2.9E+06
HEXADECANOIC ACID	1.97E+01			3.2E+03	3.6E+03	2.5E+03
METHYLENE CHLORIDE (CA) V	5.84E+00	4.81E+03	TLV	9.2E+04	9.8E+03	9.8E+03
2-METHYLNAPHTHALENE	4.79E+02	2.35E+04		8.4E+04	9.5E+04	6.7E+04
2-METHYLPHENOL & METHYLPHENOL	3.35E+01	1.09E+05	TLV	2.9E+05	3.2E+05	2.2E+05
4-METHYL-2-PENTANONE	1.97E+01	9.37E+06	TLV	2.9E+05	3.2E+05	2.2E+05
N-NITROSODIPHENYLAMINE (CA)	4.90E+00	3.72E+04		3.9E+04	4.5E+04	1.5E+04
NAPHTHALENE V	3.33E+02	3.42E+03	PEL	3.2E+05	3.3E+05	2.4E+05
NITROBENZENE	3.00E+01	1.19E+04	PEL	2.3E+03	3.2E+03	2.2E+03
OXYBIS(2-ETHOXYETHANE)	9.22E+00	5.11E+04		1.4E+05	1.6E+05	1.1E+05
PHENANTHRENE	1.09E+02	2.98E+03		3.3E+04	4.4E+04	3.1E+04
PHENOL	4.19E+01	1.99E+06	PEL	5.6E+04	6.3E+04	4.5E+04
PYRENE	3.89E+03	8.82E+05		1.1E+06	1.3E+06	9.2E+04
TETRACHLOROETHENE (CA) V	2.24E+01	1.03E+03	TLV	3.3E+03	1.4E+03	1.4E+03
TETRAMETHYLUREA	7.50E+00	3.56E+04		1.2E+05	1.4E+05	9.3E+04
TOLUENE V	5.88E+02	2.74E+03	TLV	2.4E+05	1.3E+06	1.3E+05
1,2,4-TRICHLOROBENZENE V	1.12E+03	4.79E+02	TLV	1.1E+05	1.3E+05	9.2E+04
1,3,5-TRICHLOROBENZENE	1.12E+03	4.79E+02	TLV	1.1E+05	1.3E+05	9.2E+04
TRICHLOROETHENE (CA) V	2.55E+01	1.03E+03	TLV	4.3E+04	9.7E+03	9.7E+03
1,2,3-TRICHLOROPROPANE (CA) V	3.50E+01	3.40E+04	PEL	4.9E+03	1.5E+02	7.5E+02
1,2,4-TRIMETHYLBENZENE	1.23E+02	1.97E+05		4.8E+05	5.4E+05	3.8E+05
TRIDECANE	NOT MODELED			8.7E+04	7.9E+04	5.4E+04
UNDECANE	NOT MODELED			2.9E+04	3.3E+04	2.3E+04
O-XYLENE V	8.28E+01	2.38E+03	PEL	5.9E+04	9.3E+04	4.5E+04

V = COMPOUND IS VOLATILE (Henry's law constant greater than 0.01

PEL/TLV = where available

(2) Assumes most conservative roughness height (1x10cm)

(CA) = 10/87 EPA REGION III REQUESTED THE USE OF E-06 CANCER RISK INSTEAD OF MCLs

APPENDIX A

Transport Modeling of Potential Contaminants in Ground Water As a Result of Leaching from Lagoon Soils

Contaminant transport and resulting concentrations at a hypothetical residential well have been estimated using an EPA specified approach. Cleanup levels in contaminated soils were back calculated from acceptable concentrations in a residential well for the listed compounds. The cleanup levels are given as average concentrations of contaminant in the lagoon soils.

Approach

The approach sanctioned by EPA employs the use of three models sequentially to determine the relationship between contaminant concentrations in the soils and concentrations in a hypothetical residential well;

1. The Hydrologic Evaluation of Landfill Performance (HELP) Model.

2. The Regulatory and Investigative Treatment Zone (RITZ) Model.

3. Ground water dilution model.

The models were linked so that the output of the HELP Model (infiltration and evapotranspiration) becomes input to the RITZ Model. Output of the RITZ Model includes mass transport to ground water. Mass transport to the ground water was in turn used as input to the ground water dilution model. The output of the ground water dilution model provides the basis for back-calculation of the soil cleanup levels based on acceptable concentrations in the hypothetical well.

HELP

The HELP model was used to predict the amount of infiltration and evapotranspiration in the lagoon area. The following assumptions were used in the model:

1. Climatologic data from Philadelphia, PA (1974-1978) can be used to adequately describe climatological conditions on-site.

ERM

2. The soil on-site is homogenous and can be modeled as a single layer of loam soil.

3. The surface of the lagoon has no slope.

4. The vegetation at present is "Poor".

The HELP Model predicted evapotranspiration at the site to be 0.0018 meters/day and the net infiltration was estimated to be .001 meters/day.

RITZ

The RITZ Model was used to predict mass transport to the ground water beneath the lagoons. The following assumptions were used in the model:

1. Homogeneous soil column with uniform concentrations and soil properties.
2. Uniform flow throughout the unsaturated zone.
3. Hydraulic conductivity is related to moisture content via the Clapp-Hornberger equation.
4. Dispersion is insignificant.
5. Partitioning between solid, liquid, and gas phases can be described with linear relationships.
6. Steady, uniform degradation constants based upon biodegradation or hydrolysis.
7. Finite mass of contamination, with transient loss from the system.
8. A fully mixed zone at the surface, 1 meter in depth, into which all contaminant loading is entered
9. Losses to the atmosphere via volatilization.

The maximum average concentration of leachate entering the ground water over any 70 year period for carcinogens and a 5 year period for noncarcinogens was calculated using the RITZ model.

Ground Water Dilution

A ground water dilution model was used to predict concentrations in a hypothetical residential well located on the vertical plane described by the downgradient boundary of the lagoon. The model development was straightforward and was based on a concept used for the EPA Vertical-Horizontal Spread (VHS) Model. The dilution of leachate into the residential well was determined by assuming that the well would penetrate the aquifer below the lower boundary of the contaminant plume. In this way, a percentage of clean water from beneath the plume would be drawn into the well with the contaminant plume during any pumping event. A major

source of uncertainty in the model is the hypothetical construction of the well.

With regard to well construction, the following assumptions were made:

1. The aquifer is homogeneous and isotropic in the area of concern.

2. Well pumping has no effect on the geometry of the contaminant plume or ground water flow patterns.

3. The well withdraws water uniformly from its open interval.

4. The lagoons are rectangular in plan view and no portion of the lagoon is below the water table.

Contaminated leachate from the lagoons was assumed to migrate vertically to the ground water table and move into the saturated flow field without mixing. As a result, a wedge of water contaminated at the leachate concentration Co, is formed uniformly across the front of the lagoon. This wedge has a constant thickness d at the front of the lagoon which can be determined by a mass balance calculation.

The receptor well is located at the edge of the lagoon, and penetrates the contaminant wedge for a length of its open interval. The well is considered to cause only a minor change in the ground water flow field given typical uses of a family of four. As a result, the contaminant plume surrounds the well. Assuming that the well will receive water uniformly from its entire length of open interval L, during a pumping event, the concentration of the abstracted water, Cx, is determined:

$$Cx = Co\ (d/L)$$

Well Construction

The next step in the analysis was to determine an open interval length, L, of a hypothetical residential well to be installed at some future date. The construction and depths of residential wells are highly variable. Several methods of determining a typical well construction were considered including:

1. Contacting government agencies for well requirements,
2. Contacting well drillers for typical well construction,
3. Reviewing depths of water wells near the site, and
4. Calculating depths based on aquifer parameters determined during hydrologic investigations.

No absolute requirements for well yield or depth were available from government agencies. The Farm Home Administration indicated that for new wells six gallons per minute yield was a rule of thumb but not a written requirement. Well drillers indicated that a well's open interval was very dependent upon the geology encountered which often varies greatly over relatively short horizontal distances (50 ft). An average well depth was determined from the well inventory data collected for the RI. The average depth of wells located in the Stockton formation was approximately 270 feet. However, most of these wells were industrial or municipal wells and deemed not representative of residential wells.

The selected method of determining an L value for the calculations was based on the calculated hydraulic conductivity from shallow and intermediate monitoring wells at the site. Using a formula for transmissivity of a semi-confined aquifer, calculations were made for three different production rates; 8, 6 and 4 gpm.

The calculations of d/L were performed for a range of aquifer values. The expected value of d/L = 1/34. This is the value that will be used in risk calculations. The range of d/L is from 1.1 to 1/960, approximately a factor of 30 on either side of the average.

APPENDIX B

Quantitative Assessment of Potential Intakes

The exposure scenarios selected for consideration at the Tyson's Site are as follows:

1. Hypothetical residential well - lifetime exposure

   a. Ingestion of contaminated ground water used for drinking (chronic)

   b. Inhalation of vapors from bathing with contaminated well water (chronic)

2. Direct contact to contaminated subsurface soils by road construction work crew (30-day exposure)

   a. Dermal absorption of contaminants in soil by highway workers (subchronic)

   b. Incidental ingestion of contaminated soil by highway workers (subchronic)

   c. Inhalation of contaminants adsorbed onto fugitive dusts by highway workers (subchronic)

   d. Inhalation of vapors on-site by highway workers (acute)

3. Exposure to contaminated soils by children after road construction, assuming no cover is replaced after road construction, and removal of security fence.

   a. Soil intake by children (6 to 12 years) via inhalation of dusts, ingestion of soil on hands, and dermal absorption (chronic).

Each exposure scenario is detailed below.

1. <u>Hypothetical residential well - lifetime exposure</u>

   a. Ingestion of contaminated ground water used for drinking (chronic).

Calculation of the average daily lifetime exposure level (mg/kg/day) is based on the standard man with a body weight of

The ERM

70 kg (154 pounds), and a 2-liter per day consumption of drinking water over a lifetime of 70 years. These assumptions are utilized by EPA to derive maximum contaminant levels (MCLs), adjusted acceptable daily intakes (AADIs), etc. and specified in EPA's Superfund Public Health Evaluation Manual (SPHEM).

b. Inhalation of vapors from bathing with contaminated well water (chronic)

It was assumed that because some of the chemicals which might be detected in the ground water could be highly volatile, inhalation exposure to vapors generated in confined spaces may be significant in addition to ingestion. While dishwashing, laundering, etc. may contribute to release and inhalation of volatile organic chemical (VOC) vapors, it is daily showering in an unventilated bathroom that is expected to provide the conditions which would result in substantial potential absorption of VOCs.

Not all chemicals present in on-site soils are volatile, and inhalation of vapors released from shower water is not anticipated to represent a significant exposure pathway for these compounds such as di-n-octylphthalate. The extent of volatilization will vary widely from water contaminants which are gases at standard pressure and temperature and have low solubility in water to water soluble contaminants with very low vapor pressures. For purposes of defining volatile, it is assumed that compounds with Henry's Law Constants of 0.01 and higher will completely volatilize from shower water. Compounds with values less than 0.01 are assumed to volatilize to only a minimal extent and result in the inhalation of quantities of vapors that are small relative to drinking 2 liters of the same water.

Retention factors (i.e., the fraction of the volatile organic contaminant in inspired air that is taken up into the bloodstream) for chemicals may vary widely. A value of 0.5 (i.e., 50%) is used for most volatile chemicals under resting (normal respiration) conditions in a shower stall.

The EPA's Carcinogen Assessment Group typically assumes 50% retention of inhaled vapors (e.g. see Health Assessment Document for Ethylene Dichloride). In a recent volume of Drinking Water and Health (Vol. 6, 1986) the National Academy of Sciences describes detailed studies where equivalent tissue levels (e.g. blood, liver, etc.) from inhalation and drinking water exposures have been determined precisely for benzene and trichloroethene (TCE). For trichloroethene, an effective concentration of metabolite formed in the liver from drinking water containing 403 mg/L (in 6 divided doses) was equivalent to inhalation of air containing 302.4 mg/m^3 of TCE over an 8-hour period. For a human this would represent 806 mg ingested in 2 liters, or 2032 mg

inhaled in 6.72 m^3 in 8 hrs as producing equivalent tissue concentrations of TCE metabolites. Accordingly, inhalation results in only about 40 percent absorption compared to ingestion for TCE. A similar study with benzene (blood levels) revealed that inhalation was about 41% as efficient as ingestion of benzene in drinking water.

2. Direct contact to contaminated subsurface soils by road construction work crew

a. Dermal Absorption of contaminants in soil by highway workers (subchronic)

The percutaneous absorption of chemical pollutants from contaminated soil or dust which adheres to the exposed skin will depend upon: 1) the concentration of the chemical in soil; 2) the area of skin covered with contaminated soil; 3) the duration of contact; 4) the binding affinity of the contaminant for soil elements; 5) the moisture content of the skin and soil; and 6) the ability of the chemical, per se, to penetrate the dermis.

For the purposes of estimating dermal exposure and absorption of contaminants, it is assumed that for highway construction workers, the areas of exposed skin include the hands, the forearms, and the back of the neck. These workmen were assumed to weigh 70 kg and average 170 cm in height. According to EPA's Superfund Exposure Assessment Manual, the total surface area of an adult male's skin is 18,150 cm^2 (U.S. EPA, 1986b). The skin surface area of arms (fingertips to shoulders) contributes about 19% of the total body surface area (1.81 m^2) of an adult male (Documenta Geigy, 1973). The area of soil contact, then, is taken to be half this area and includes the skin covering the total area of both hands, and forearms. The exposed area of the back of the neck is about 150 cm^2.

$$0.5\ (0.19 \times 18{,}150\ cm^2) + 150\ cm^2 = 1870\ cm^2$$

This is in close agreement with Hawley (1985) who estimated a skin exposure area (soil covering) of 1700 cm^2 for an adult male.

The duration of soil contact (completely covering both hands, both forearms and back of neck) is assumed to be 12 hours each work day, allowing for continued absorption until the dirt is removed from the soiled skin. This is a conservative assumption since it is assumed that no washing occurs until 4 hours after the work period exposure has ended and all dermal adherence of contaminated soil occurs at the very start of the 8-hr work shift.

Empirical measurements of the amount of dirt which can adhere to the skin of children indicate quantities of about 0.5 mg/cm^2. By removing dirt with an adhesive, Lepow and coworkers (1974, 1975)

determined the mean weight of hand dirt from a 21.5 cm^2 portion of a child's hand was 11 mg. This corresponds to approximately 150 mg of dirt over all the skin on both hands (300 cm^2) of a 2-1/2 year old. Roels and coworkers (1980) measured the quantity of lead on the hands of 11-year-olds in a playground by removing the lead from the dominant hand with dilute nitric acid. By comparing the lead levels in the acid solution with the concentration of lead in surficial playground soil the authors estimated a soil load of 0.13 to 0.60 mg/cm^2 of skin for the soiled hand. Thus, Lepow's published value of 0.51 mg $dirt/cm^2$ of skin appears to be a reasonable, conservative estimate.

Dermal absorption of chemicals applied to the skin will be most likely to occur for compounds with low molecular weight, which are both water soluble and lipid soluble, and which can remain on the skin for a prolonged duration. Highly volatile chemicals can be expected to evaporate rapidly. Studies by Bartek et al. (1972) and Feldmann and Maibach (1970) who applied various radio-labeled organic compounds to the forearms of humans indicate that, with few exceptions (e.g., caffeine), the absorption over a 24-hour period ranged from 0.4% to 10.8%. Hawley (1985) assumed an absorption rate of 1% per 24 hours as conservatively representative of all organic chemicals if dermally applied in pure form in an acetone vehicle. Hawley assumed that for a 12-hour exposure period, the rate of absorption of pure compound is 6 percent (Hawley, 1985).

Using TCDD (a chemical not found at the Tyson's site), Hawley (1985) estimated the effect of the soil matrix was to reduce the absorption rate to about 15% of that for pure compounds. This factor was based upon the observed reduction in dermal absorption when high ppm concentrations of TCDD in a soil/water paste were compared to TCDD in a methanol solution. The attenuating effects of soil may be much more significant for soils containing low ppb levels of non-volatile organic compounds. On the other hand, TCDD has a much higher affinity for soil elements (K_{OC} = 3.3×10^6, $\log K_{OC}$ = 6.52) than most other organic chemicals (e.g., the $\log K_{OC}$ for 1,2,4-trichlorobenzene is 3.96).

The 0.15 soil attenuation factor employed by Hawley was used to account for the matrix effects in dermal absorption of the contaminants from soil. The influence of the soil matrix is likely to depend greatly on properties of the specific chemical and soil as well as concentration. However, in the absence of specific information a dermal absorption over a 12-hour period for all non-volatile organic chemicals has been derived by Hawley as follows:

6 percent (absorption pure compound) x 0.15(soil matrix effect) =

0.9 percent

A linear relationship between duration of exposure and extent of absorption for compounds applied on the skin in pure form (a solvent vehicle) was assumed in this model. This may not be valid for absorption of chemicals from a soil matrix coating the skin. It is possible that absorption of chemicals from soil or skin could be limited by the amount of free chemical at the soil-moisture-skin interfaces. Rates of dermal uptake may depend in large part upon the desorption and diffusion of the chemical and its availability at the dermal interface. Desorption and diffusion rates are inversely related to the affinity of the chemical for the organic carbon (and perhaps other) elements of the soil matrix. Thus, some compounds (such as the TCDD studied by Hawley) which exhibit a very high affinity for soil elements may not readily diffuse to the soil-skin interface as the available free chemical is dermally absorbed and exhausted.

For other non-volatile organic chemicals the affinities for soil elements (related to Koc) may be much less than that of TCDD. The attenuating effects of soil on the percutaneous absorption of chemicals, therefore, may not be accurately represented by Hawley's observations. Therefore, the potential adsorption onto skin is estimated by means of Fick's Law of diffusion.

Fick's law may be used to determine the permeation rate of chemicals in an aqueous solution, and is given by the equation:

$$J_S^o = K_p^o \ C_s^o \qquad (1)$$

where J_s^o is the permeation rate (flux) of the solute expressed as $mg/cm^2 \times hr$; K_p^o is the permeability constant (liters $cm^2 \times hr$); C_s^o represents the concentration difference of the solute across specified tissue in mg/liter (Brown, et al, 1984). Fick's law is applied to dilute aqueous solutions and is assumed that absorption of the solute will be directly proportional to concentration.

The permeability constant K_p^o used is the highest value reported in the literature for the compounds ethylbenzene, styrene, toluene, and xylene (Brown, et al., 1984). Thus, the value used is that for ethylbenzene:

$$K_p^o = 0.001 \text{ liters/cm}^2 \times \text{hr} \qquad (2)$$

For 1,2,3-trichloropropane (TCP) it is assumed that the concentration difference, C_s^o, across specified tissue is 73.7% of the solubility of TCP in water (1,900 mg/L), equivalent to the

percent solubility concentration of ethylbenzene used to derive the permeability constant stated above:

$$C_s^o = 0.737 \times 1{,}900 \text{ mg/liter} = 1{,}400 \text{ mg/liter} \quad (3)$$

Substitution of these values for K_p^o, and C_s^o into equation (1) results in:

$$J_s^o = (0.001 \text{ liters/cm}^2 \times \text{hr})\ (1{,}400 \text{ mg/liter}) = 1.4 \text{ mg/cm}^2 \times \text{hr} \quad (4)$$

Over a 12-hour period the skin absorption rate is:

$$J_s^o = 16.8 \text{ mg/cm}^2 \quad (5)$$

For TCP the water/organic carbon partition coefficient is:

$$K_{oc} = 0.688 \text{ m}^3/\text{kg} \quad (6)$$

For Tyson's site an f_{oc} coefficient (organic carbon content) of 0.001 is used for conservativeness. Thus, the sorption coefficient is:

$$K_d = (K_{oc})\ (f_{oc}) = (0.688)\ (0.001) = 6.88 \times 10^{-4} \text{ m}^3/\text{kg} \quad (7)$$

Calculation of the soil attenuation factor is based on the concept of relative velocity of adsorbed and nonadsorbed solutes through a porous material. Such a relative velocity is described by the equation:

$$\text{Relative velocity} = 1/R_d = 1/(1 + (\rho/\emptyset)K_d)$$

where R_d is the retardation factor, ρ is the soil bulk density in kg/m^3, K_d is the sorptionm coefficient in m^3/kg, and $\emptyset$ is the soil porosity (expressed as a fraction). Using a soil porosity of 0.3, the soil attenuation factor is:

$$\text{Soil attenuation factor} = 1/(1 + (1500 \text{ kg/m}^3/0.3)0.000688 \text{ m}^3/\text{kg}) = 0.2252$$

Thus, the dermal absorption over a 12-hour period taking into account the soil matrix is:

16.8 (absorption rate pure TCP compound) x 0.2252 (soil matrix effect) = 3.78 percent

For the purposes of this exercise, this percutaneous absorption rate is conservatively assumed for all organic compounds considered.

Assuming a skin exposure area of 1870 cm^2 for workers, the amount of soil adhering to the skin is estimated to be 954 mg. Since the dermal absorption is assumed to be 3.78%, the amount of soil contaminant absorbed in 12 hours is estimated to be equivalent to the amount of contaminant contained in 36 mg of contaminated soil, as follows:

Area of exposed skin	=	1870 cm^2
Soil adhering to exposed skin	=	0.51 mg/cm^2 x 1870 cm^2 = 954 mg
Absorption rate pure compound	=	16.8%/12 hour
Soil matrix effect	=	0.22

1870 cm^2 x 0.51 mg/cm^2 x 0.0378 = 36 mg soil/day

36 mg soil/day x mg contaminant/mg soil = mg of chemical absorbed/day

b. Incidental ingestion of contaminated soil by highway workers (subchronic)

For purposes of risk analysis, it was assumed that highway construction workers do not practice hygienic habits. Accordingly, some site soil adhering to the skin of the hands may be transferred to food or cigarettes. Hawley (1985) reported that the inside surface of the fingers and thumb represents 14% of the surface area of a hand. The surface area of both hands of an adult is taken to be 910 cm^2 (Documenta Geigy, 1973; Borkow, 1924). In handling food (e.g., a sandwich), it was assumed that the thumb and finger pads represent the points of contact between "dirty" hands and food. To be conservative, it is further assumed that half of the total skin on the insides of all fingers and thumb contact the food, and the transfer of contaminated soil from skin to food is 100%. The amount of dirt on this skin surface is assumed to be be equivalent to the measured levels of soil on children's hands (Lepow, 1974), which is 0.51 mg/cm^2. Thus, the incidental ingestion of contaminated soil from eating a sandwich or other food is derived as follows:

Ingestion of soil with food = 0.14 x 910 cm^2 x 0.5 x 0.51 mg/cm^2 = 32.5 mg

Other related potential pathways of soil intake include incidental transfer from soiled arms, hands, fingers, or perspiration to lips, nostrils, and eyes (conjunctiva). Ingestion or mucosal absorption via these pathways is difficult to estimate, but is not expected to be substantial. Assuming that the lips are completely coated 3 times during the course of

a workday with a 10 um film of soil, all of which is ingested, it is roughly estimated that the soil intake would be:

Soil ingestion from incidental contact = 9 cm^2 x 0.0010 cm x 1500 mg/cm^3 x 3 = 40.5 mg soil

where:

9 cm^2 = surface area lips
0.0010 cm = thickness of soil film on lips from dust deposition and transfer from arms, hands, or fingers
1500 mg/cm^3 = density of dry-weight soil
3 = assumed frequency of soiling

The total estimated ingestion of soil is derived by summing the transfer pathways.

Transfer to food	- 32.5 mg
Transfer to lips & mucosa	= 40.5 mg
Total soil ingested	= 87 mg/day

c. Inhalation of contaminants adsorbed onto fugitive dusts by highway workers (subchronic)

A subchronic exposure of 6 weeks maximum was assumed. It was assumed that 75% of dusts inhaled are retained (25% exhaled) (Cowherd, 1984); of the dusts retained, 100% is absorbed. Appendix D describes procedures used to estimate fugitive dust emission rates and resulting concentrations in inhalable air.

Assuming that a construction worker inhales $10m^3$ of dust-laden air during an 8-hour day, and 75% of the contaminants adsorbed onto inhaled fugitive dusts are retained, the amount of soil contaminant absorbed in 8 hours is estimated to be equivalent to the amount of contaminant contained in 2 mg of contaminated soil.

The total daily intake from all routes of exposure for road construction workers is the amount of contaminant contained in 125 mg Soil.

ingestion	87 mg/soil/day
dermal absorption	36 mg soil/day
dust inhalation	2 mg soil/day
total	125 mg soil/day

A soil concentration corresponding to an acceptable subchronic intake (AIS) can be calculated by applying the AIS to the amount of the contaminant absorbed daily from 127 mg of soil as follows:

$$\text{Acceptable soil concentration for road crew (ppm)} = \frac{\text{mg contaminant}}{\text{mg soil}} \times \frac{10^6 \text{ mg}}{\text{kg}} \times \frac{\text{AIS (mg/kg/day)} \times 70 \text{ kg}}{125 \text{ mg soil intake/day}}$$

For carcinogens (i.e., chemicals classified as Group A or B under EPA's classification scheme), a level of risk corresponding to 10^{-6} (i.e., one in a million) is regarded as an acceptable exposure. The EPA carcinogenic potency factors were utilized to quantify risk. (See Appendix C regarding the derivation of these factors and the use of the terms "carcinogen" and "cancer risk".) Since the potency factors are based on an assumed lifetime exposure (365 days per year for 70 years), exposures occurring over a period substantially less than a lifetime are assumed to be proportionately less. This assumption which has ample historical precedence is based on the probability of a specific response (e.g., liver neoplasm) by time t, under constant dose rate d, and depends on the values of d and t only through their product, dt. This is referred to as the time/dose product rule. Accordingly, the predicted cancer risk from subchronic exposure can be related to an equivalent exposure over a lifetime by converting the carcinogenic potency factors (CPFs) from daily exposure units to total lifetime exposure risk units:

$$\frac{10^{-6} \text{ risk}}{\text{CPF}} = \text{mg/kg/day corresponding to } 10^{-6} \text{ risk}$$

$$\text{mg/kg/day } @ 10^{-6} \text{ risk} \times 365 \text{ days/yr} \times 70 \text{ yrs/lifetime}$$

$$= \text{mg/kg/lifetime} = \text{the } 10^{-6} \text{ lifetime risk exposure (LRE)}$$

For subchronic exposures to road construction workers (i.e., 30 days total) the total risk associated with a daily exposure level can be estimated by simply dividing the 10^{-6} lifetime-risk exposure level by the number of days of exposure.

$$\frac{10\text{-}6 \text{ LRE}}{30 \text{ days/yr} \times 1 \text{ yr}}$$

This, then, is substituted for the AIS in the equation above to derive a corresponding soil concentration.

d. Inhalation of vapors on site by highway workers (acute)

Subsurface soil volatile contaminants exposed to air as a resul of grading activity may undergo volatilization and release int ambient air. Rates of release and ambient concentrations ar estimated by techniques described in Appendix D. OSHA's Permissible Exposure Limits (PELs) or TLVs, where no PEL has been established serve as determining criteria for acute exposures to workmen.

3. Soil intake by children (6 to 12 years) via inhalation of dusts, ingestion of soil on hands, and dermal absorption of soil adhering to exposed skin, assuming soil cover not in place.

The scenario assumed accessibility to the site after vacuum extraction activities have been completed. (During vacuum extraction, the site will be secured). The scenario further assumed that there is no cover replaced after the soil is disturbed.

For the purpose of estimating chronic oral, dermal, and inhalation exposures by children to soils on-site; the following conservative assumptions, though not necessarily expected to occur, were used:

- Children aged 6 to 12 years will play an average of 52 days per year for 6 years;
- only 50% of the time will be spent in areas of surface soil contamination (ie, 26 days/year);
- average playtime is 4 hours per day;
- average dust levels are assumed to be 70 ug/m^3
- approximately 75% of the inhaled mass is retained
- average respiratory rate for children aged 6 to 12 years 11.6 liters/minute (i.e. 0.7 m^3/hr);
- incidental ingestion of 50 mg soil adhering to hands.
- approximately 207 mg of soil may adhere to the skin surface (based on soil covering the skin of knees, legs, forearms, and hands); and
- percutaneous absorption rate of 3.74%.

a. Average Daily Dust Inhalation:

$$0.7\ m^3/hr \times 4\ hr/d \times 0.75 \times \frac{70ug}{m^3} \times \frac{1mg}{1000ug} = 0.147\ mg\ soil/event$$

b. Dermal Absorption:

207 mg soil x 0.0374 = amount of contaminant contained in 7.74 mg soil

c. Oral-incidental ingestion

50 mg/day

Total Exposure level = oral + dermal + inhalation

= 50 + 7.74 mg + 0.15 mg = 58 mg soil per exposure

Since exposures are estimated to occur 26 d/yr, the average daily dose is equivalent to 4.12 mg/day.

The maximum acceptable level for Group A and B carcinogens is:

$$\frac{1 \times 10^{-6}}{CPF} \times 26\ kg = mg/day\ @\ 10^{-6}\ predicted\ cancer\ risk$$

The maximum acceptable level for non-carcinogens is:

ADI (RFD) x 26 kg = mg/day.

To determine the mg contaminant per mg of soil (the actual exposure level) the maximum acceptable level is divided by the total soil exposure level. This exposure level is converted to ppm. As needed when using carcinogenic potency factors, a conversion from 70 year to 6 year exposure is made. The acceptable soil levels by children aged 6 to 12 are then compared to actual soil levels.

For the calculation of subchronic exposure levels in children, the factor of 26d/365d is removed and the levels are recalculated.

$$\text{acceptable soil conc.} = \frac{\text{mg chemical}}{\text{kg soil}}\ (ppm) = \frac{\text{acceptable intake chronic} \times 26\ kg\ (mg/kg/day)}{4.12\ mg\ soil/day} \times 10^6$$

Under subchronic standards:

$$\text{acceptable soil conc.} = \frac{\text{mg chemical}}{\text{kg soil}} \text{ (ppm)} = \frac{\text{acceptable intake subchronic (mg/kg/day)} \times 26 \text{ kg}}{58 \text{ mg soil/day}} \times 10^6$$

ERM

APPENDIX C

Determination of Acceptable Intake Levels

The level of intake for a chemical that can be regarded as acceptable will depend upon the frequency and duration of the intake. For example, an acceptable daily intake of a substance which accumulates in the body will be much lower when the dose is continuous over many years than for a tolerable one-time exposure dose.

Each of the exposure scenarios outlined considered different durations and frequencies of intake episodes. Depending upon the length of exposure, as defined by each scenario, criteria were developed for chronic, subchronic, and acute intake levels by various routes. For chemicals treated as carcinogens based upon their classification in Group A and B, according to EPA's classification scheme, risk is normally based on a lifetime exposure, and risk potency factors are determined for daily exposure levels over a period of 70 years. In certain scenarios the anticipated period of exposure is considerably less than a lifetime. In these circumstances, the lifetime potency factors were utilized and risk was assumed to be proportional to the fraction of the lifetime over which exposure is expected to occur. It should be noted that EPA's carcinogenic classification is generally based on extrapolating either long-term high dose animal studies or epidemiology findings to the human population. The EPA's risk quantification model use for extrapolation is conservatively designed to be protective of human health. Therefore, this reported risk generally represents a number that is not likely to be higher but is likely to be lower.

For many of the listed chemicals MCLs, maximum contaminant level goals (MCLGs), acceptable intake chronic (AICs), acceptable intake subchronic (AISs), risk reference doses (RfDs), and other EPA-generated criteria, guidelines or advisories, have been published. For others, however, which have no such standards, it was necessary to develop acceptable intake levels. Where more than one guideline was available, a selection of the most appropriate standard is based on considerations consistent with current EPA policy (Section 121 CERCLA; FR 52, No. 116, August 27, 1987, p. 32496). The selection or development of an acceptable intake level for a given chemical will depend upon the information available for that chemical. The hierarchy of the decision logic is given below.

1. Where available and where appropriate (e.g., lifetime exposure to contaminated drinking water), promulgated standards should be applied. The most appropriate standards are MCLs (FR 52, No. 166, August 27, 1987, p. 32497). However, where carcinogenic compounds are involved, EPA has stipulated that MCLs are inappropriate as cleanup levels unless MCLs are available for all carcinogens considered. In this circumstance, acceptable levels are selected such that the predicted cancer risk falls within the acceptable risk range of 10^{-4} to 10^{-7}. For the individual carcinogens, a soil concentration corresponding to a 10^{-6} risk is determined to be the cleanup standard. EPA's carcinogen potency factors, as published in the Superfund Public Health Evaluation Manual (SPHEM, 1986), are utilized to quantitatively estimate cancer risks.

2. For non-carcinogenic chemicals, acceptable daily intakes for chronic exposure are selected on the basis of established chemical-specific advisory levels that are protective of human health and the environment. While they are not ARARs, wherever available, MCLGs are used for this purpose. The EPA's risk-reference doses (RfDs), and the AIC (chronic) and AIS (subchronic) advisories published in the SPHEM are also guides for this purpose.

3. For chemicals, which have not been evaluated by EPA in terms of deriving an RfD, AIC, AIS, etc., it is necessary to develop an ADI (acceptable daily intake, which is equivalent to EPA's RfD) from data generated by the most reliable long-term toxicity studies in animals. The highest, confident no-observed-adverse-effect level (NOAEL) obtained in animals is divided by safety factors that incorporate uncertainties associated with animal-to-human dose equivalencies, variability of human response, and an additional uncertainty factor for less than a lifetime dosing regimen or other considerations. (Subchronic NOAELs or LOELs may be utilized provided the studies were reliable and an additional safety factor of 10 is applied). These guidelines have been adopted by the National Academy of Sciences and endorsed by EPA.

4. Some chemicals lack sufficient toxicological information to ascertain a NOAEL to derive a suitable ADI. In these circumstances, a search will be conducted to compile available LD_{50} data. Generally, the lowest oral LD_{50} value for any species was used. This value was divided by appropriate safety factors,

depending on anticipated duration of exposure, to develop provisional acceptable intakes:

a) LD_{50} 100,000 = acceptable chronic intake
b) LD_{50} 10,000 = acceptable subchronic intake

Application of these safety factors is a commonly used, conservative approach that can be applied generically when substance-specific data are lacking.

5. In rare instances, only (TLV) data may be available. In these cases, acceptable intake levels can be derived by correcting for continuous exposure and dividing by 100 to account for highly sensitive segments of the non-working population (e.g., the infirm, the neonate, etc.). Use of 100 as a safety factor is conservative.

6. For those chemicals that lack toxicity information at all, it may be necessary to apply concepts of structure-activity-relationships and derive acceptable intake levels by inference and analogy to closely related compounds. Professional judgment is tempered with conservatism in these situations.

APPENDIX D

Estimation of Fugitive Dust Emission Rates and Potential Volatilization of Subsurface Soil Contaminants During Roadway Construction

Fugitive Dust Emission Rates

four types of activities in construction of a possible roadway have the potential to generate fugitive dust:

1) Rough grading of the roadway
2) Placement of crushed stone
3) Blacktopping of surface
4) General traffic over unpaved surfaces

Estimation of fugitive dust emission due to each activity is examined separately as follows:

1) Rough grading of the roadway. Rough grading is expected to be performed by a bulldozer. An estimate of particulate emissions <15 um in diameter due to bulldozing activity can be found in EPA, 1985 (Table 8.24-2):

$$E = (1.0 (s^{1.5})/(M^{1.4})$$

where:

s = percent silt content
M = percent soil moisture
E = emission factor in lb/hr

A soil moisture content of 11.8 percent was selected based upon previous sampling results (Woodward Clyde Consultants, average of 32 core samples taken during the site assessment, 1985), and a silt content value of 24% is assumed from EPA, 1985 in the absence of site specific data (Table 11.2.1-1; figure is for a haul road, freshly graded). Substitution of these values yields an estimate of an emission rate for dust of 3.7 lbs/hr. It should be noted that all equations presented quantify the generation of dust of less than or equal to 15 um in diameter only; generation of particles larger than this is not included. Bulldozing activity was assumed to take place 8 hrs/day for 8 days.

2) Placement of crushed stone. Placement of crushed stone takes place in progressively shorter truck trips, i.e., the first truck travels the entire length of the roadway, dumps stone, then returns to its starting point; the second truck travels a shorter distance, dumps stone, and returns; etc. Generation of fugitive dust of concern was assumed to take place only while trucks loaded with stone travel over stone-uncovered surface. EPA 1985 contains an empirical expression that can be used for the estimation of fugitive dust generation from travel over unpaved surfaces:

$$E = k(5.9)(s/12)(S/30)((W/3)^{0.7})((w/4)^{0.5})((365-p)/365)$$

where:

s = percent silt content
k = particle size multiplier
S = mean vehicle speed, mph
W = mean vehicle weight, ton
w = mean number of wheels per vehicle
p = mean number of days with > = 0.01 inches of precipitation per year
E = emission rate in lb/vehicle mile traveled (VMT)

Percent silt content was assumed to be 24% based on data discussed above. The particle size multiplier used is 0.50, corresponding to particles less than 15 microns. Mean vehicle speed was assumed to be 15 mph. Mean vehicle weight is assumed to be 32 tons, an average of the full weight (43.5 tons) prior to dumping and the unloaded weight (20.5 tons) on the return. The vehicles used in this activity have 14 wheels per vehicle. Mean number of days with less than 0.01 inches of precipitation per year is 117. Substitution of these values yields an estimate of fugitive dust generation of particles <=15 microns of 19.6 lbs/VMT. A total of 800 tons of stone is estimated to be required by the 1400-foot roadway, or an estimated 40 truckloads. An average truck trip of 1400 feet was assumed (an average of all trips, with the first truck traveling 2800 feet, the last traveling 0 feet). Placement of stone is expected to occur over 4 days, 8 hrs/day. This results in an estimated 1.25 trips per hour. Based on these assumptions, the estimated emission rate of dust during placement of stone is 6.5 lbs per hour; this activity will occur 8 hrs per day for 4 days.

3) Blacktopping. Traffic over unpaved surface during blacktopping will occur minimally, especially due to limited space available on the sides of the roadway and is not estimated here.

4) General traffic. Additional miscellaneous traffic over unpaved surface is expected to be minimal, given the short time frame for construction of the roadway and the subsequent level of activity during construction. Fugitive dust emission is expected to be negligible compared to other activities.

For the subchronic exposure scenario, calculated fugitive dust emission rates were converted to concentrations using a "box" model. Use of this model assumes that the base of the box is determined by the amount of site area disturbed via stone placement activity (1400 x 44 ft), the box height is determined by the base length and a roughness height for a non-vegetated surface (1cm), wind speed is 1 m/s, and particles of the size class <15 um are transported the same as volatile organics. The percentage of potential area available for roadway construction that could be occupied by contaminated material in the future was estimated by calculating the percentage of available area now occupied by contaminated soil; contaminated soil presently occupies approximately 32% of the remaining surface area in the former lagoon area.

Volatilization of Subsurface Soil Contaminants

The following procedures were used to estimate emission rates from disturbed soils at Tyson's Site. It was assumed that 13,125 ft^3 of soil would be disturbed, obtained from a maximum depth of 5.0 feet, and would be spread over an area of 175'x44' (estimates of site-specific activities involved in roadway construction were developed based on existing design plans for a service roadway through the lagoon area).

The emission rate, Q, from the land surface can be approximated by the equation (Federal Register, Vol. 50, No. 229, pg. 48964):

$$Q = \frac{CiW}{td} \qquad (1)$$

where:

Q = emission rate (mg/sec)
Ci = constituent concentration in the soil (mg/kg)
W = weight of soil (kg)
td = time period within which volatilization occurs (sec)

For the case being considered, by using a bulk density of soil equal to 1,500 kg/m^3, the weight of the soil material is:

$$W = (13,125\ ft^3)(1,500\ kg/m^3)(0.3048\ m/ft)^3 = 557,487\ kg$$

The time it takes for the contaminant to be volatilized from the soil can be estimated from the equation (U.S. EPA "Superfund Exposure Assessment Manual", January 14, 1986, pg. 3-30):

$$t_d = \frac{h^2 - d^2}{2D} \qquad (2)$$

where:

h = depth from soil surface to the bottom of the contaminated region (cm)
d = depth of dry zone at sampling time (cm)

D (cm^2/sec) is related to the amount of contaminant i that diffuses from the soil to the air. D can be estimated as follows (U.S. EPA, "Superfund Exposure Assessment Manual", January 14, 1986, pg. 3-29):

$$D = D_i P_t^{4/3} H_i \qquad (3)$$

where:

D_i = diffusion coefficient of component i, (cm^2/sec)
H_i = Henry's Law constant (dimensionless form)
P_t = total soil porosity (dimensionless)

To obtain a worst case estimate of emission rates, the total porosity is used for Pt. In this study the total porosity is 0.561.

The depth from soil surface to the bottom of the contaminated region was:

$$h = \frac{13,125\ ft^3}{(175 \times 44)\ ft^2} = 1.7045\ ft = 52\ cm$$

The depth of the dry zone was assumed to be zero.

For the acute exposure scenario, calculated volatilized contaminant emission rates were converted to concentrations using a "box" model. Use of this model assumes that the base of the box is determined by the amount of site area that can disturbed via bulldozing activity in one day (175 x 44 ft), the box height is determined by the base length and a roughness height for a non-vegetated surface (1 cm), wind speed is 1 m/s, and the area of maximum concentration of contaminants in soil is disturbed.

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Addendum to Tyson's Responsiveness Summary
March, 1988

In January, 1985 EPA announced excavation as the selected clean-up alternative for the Tyson's site. The Superfund statute expired in September, 1985 and was reauthorized in October, 1986. In November, 1986 Ciba-Geigy Corporation of Ardsley, New York, a responsible party at the site, requested that EPA review a new technology known as vacuum soil extraction as the site cleanup alternative. Following several meetings with EPA, DER and the Upper Merion Township local officials, Ciba- Geigy conducted a pilot program at the Tyson's site in Spring, 1987. They also invited the local media and the local officials to tour the site and observe the project. EPA met repeatedly with the township officials, explaining each new development as it occurred. In September 1987 after close review of the technology EPA decided to recommend a ROD change, to include vacuum extraction.

A decision on the recommendation was made after the Upper Merion Township Supervisors voted 3-2 in favor of the new proposed method. Because of the ROD change, several requirements had to be met before the Agency could officially order Ciba-Geigy to begin the work. On January 8, 1988, EPA announced that a public meeting would be held on January 26 to discuss the new proposed alternative, and that a 30 day comment period was in effect until February 10. A quarter page add was published in the Norristown Times Herald listing all the cleanup alternatives, along with EPA's recommendation for vacuum soil extraction. Due to freezing road conditions, the public meeting had to be rescheduled for Wednesday, February 3. In addition, the public comment period was extended to February 19. EPA met in the afternoon of February 3, 1988 with representatives from Ciba-Geigy, Terra-Vac, and ERM. A premeeting with EPA, DER and township officials was also held just prior to the public meeting. A court reporter was present at the public meeting to document all comments received as part of the official record for the site. A transcript of the meeting is available at the site repository, at the Wolfsohn Memorial Library, Town Center Road, King of Prussia, Pa.

The public meeting was opened by Nanci Sinclair, with a description of the ROD change and the requirements under the new Superfund Bill, as ammended by Superfund Ammendment and Reauthorization Act (SARA) of 1986. Tim Travers did a site technical presentation, and Jim Malot of Terra-Vac did a slide presentation about the vacuum soil extraction process. Included in the presentation, were slides of the on-site pilot program. After the presentations were complete, the meeting was opened to questions and answers. EPA toxicologist Dr. Richard Brunker attended the meeting to answer health questions. The following is a summary of that portion of the meeting:

Most residents were interested in what areas of the soil would be cleaned up if vacuum extraction is used. EPA based its' answer on the evaluation of the results of the pilot test, submitted by Ciba-Geigy in June, 1987. The residents were told that the soil zone and the bedrock zone would be cleaned up, and that a 20 to 40 foot radius around the well would be cleaned by using vacuum extraction to remove the contamination from the soil.

Tyson's Responsiveness Summary Addendum
March, 1988

A resident stated that he believed vacuum extraction is a much less effective alternative than excavation, and that the discussions have lasted too long, with nothing actually being cleaned up for the past four years. EPA explained that this new alternative was not available when the Feasibility Study was conducted, and there are requirements for public participation that must be met before a new Record of Decision is signed. In addition, EPA explained that through further investigation it was discovered that most of the contamination from the lagoon areas had migrated into the bedrock and excavation would not remove all the residence contaminants from the area underlying the site. Several residents asked if excavation followed by vacuum extraction would be a better way of remediating the site. EPA answered that vacuum extraction would be a safer method not only for the surrounding community, but also for the workers on site. We also explained that under the new Superfund Law, EPA is looking into on-site technologies rather than taking environmental contamination from one site to another. Dr. Brunker explained the scenarios that were taken into account before EPA recommended the new alternative. He explained that EPA performed a quantitative risk assessment wich looks into how much soil children would be exposed to while playing outside, and how much exposure there would be to by on-site workers. He also told the residents that the site would be cleaned to levels that are not harmful. Another resident asked that his statement become part of the official resord. He stated that a total clean up solution is his preferance.

One resident asked what happens to the site after it is cleaned up. EPA replied that the Superfund Law does not address site ownership, and that ownership of the property would remain with General Devices. A resident stated that the township wants to build a highway which would run through part of the site, and she wanted to know if there would be a threat to workers who would have to excavate the area in the future. EPA informed the resident that worker exposure was also calculated during the quantitative risk assessment. We calculated that the levels we would clean to would protect the aquifer and that those levels were extremely conservative. Dr. Brunker explained that if we cleaned down to levels to satisfy the aquifer protection criteria in the soil, it would satisfy the protection of children who play in the area and the protection of workers who work there 8 hours a day.

A transcript of the public meeting is available at the site repository which is the Wolfsohn Memorial Library on Town Center Road. Several residents asked where all of the documents and models can be reviewed. During the comment period which lasted from January 8 to February 19, only two written comments were received. One resident fully supported the vacuum extraction process. The other letter was a general comment, requesting that EPA expedite the Tyson's cleanup project.

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Regional Administrator
U.S. Environmental Protection Agency
841 Chestnut Building
Philadelphia, PA 19107

Re: Tyson's Dump Site

Dear Mr. Seif:

This letter represents the Department's concurrence on the Record of Decision issued by EPA on March 31, 1988, and supplements our letter to you dated September 16, 1987. As you know, the Department has signed a Consent Decree with the United States and several defendants in this case, which was recently lodged with the Court. Our concurrence on the March 31 ROD is based upon the remedial actions, and the procedures for intergovernmental cooperation, embodied in that settlement document. Therefore, we concur with the vacuum extraction remedy and other response actions decided in the ROD insofar as they are properly completed pursuant to the Consent Decree.

Department personnel have been working closely with the Region in review of technical submittals by the settling defendants, and in identification of special ARARs, for design and implementation of the ROD. We view the cooperative effort on this site as exemplary and we expect that it will continue until completion of the project.

Sincerely,

Mark M. McClellan